Corrective Measure Study
SMA 5 – Former Pig Iron Foundry
(Revision 1.2)

ERP Coke
3500 35th Avenue North
Birmingham, Alabama
US EPA ID No. ALD 000 828 848

April 14, 2017
Terracon Project No. E1147106

Prepared for:
ERP Compliant Coke, LLC
Birmingham, Alabama

Prepared by:
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terracon.com

Terracon

Environmental ■ Facilities ■ Geotechnical ■ Materials

April 14, 2017

ERP Coke
3500 35th Avenue North
Birmingham, Alabama 35207

Attention: Mr. Don Wiggins

Re: **Corrective Measures Study**
SMA 5 – Former Pig Iron Foundry (Revision 1.2)
ERP Coke
3500 35th Avenue North
Birmingham, Alabama 35207
US EPA ID No. ALD 000 828 848
Terracon Project No. E1147106

Dear Mr. Wiggins:

Terracon Consultants, Inc. (Terracon) is pleased to submit this Corrective Measures Study (CMS) for activities in conjunction with the site referenced above.

Should you have any questions or require additional information, please do not hesitate to contact our office.

Sincerely,
Terracon Consultants, Inc.

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EXECUTIVE SUMMARY

Under the September 24, 2012 Administrative Order on Consent (2012 AOC) between Walter Coke, Inc. and EPA, the Former Pig Iron Foundry (FPIF) is Solid Waste Management Unit (SWMU) Management Area (SMA) 5. This CMS is submitted on behalf of ERP Compliant Coke, LLC (ERP Coke), which acquired certain assets of Walter Coke, Inc., including the facility at which SMA 5 is located, in a transaction in which ERP Coke agreed to implement the 2012 AOC. SMA 5 contains three SWMUs and one Area of Concern (AOC):

- SMWU 43 – Pig Machine Slurry Pits
- SWMU 44 – Blast Furnace Ash Boiler Pit
- SWMU 45 – Slag Drying Beds
- AOC C – Former Pig Iron Foundry

The operation of the facility now owned by ERP Coke can be traced back to 1881 when Sloss-Sheffield Steel and Iron Company first began producing pig iron in Birmingham, Alabama. In 1920, Sloss-Sheffield Steel and Iron Company built two modern coke oven batteries, at the time in North Birmingham, to serve its own needs as well as those of other customers. As Birmingham's steel industry grew, so did the need for furnace coke, which prompted the construction of three more batteries at the site during the 1950s.

The original coke manufacturing facility began operation in 1920 as Sloss Sheffield Steel and Iron Company. Beginning in 1952, the company experienced a series of corporate reorganizations and several name changes culminating in the name change to ERP Coke in May 2009. The following operations have occurred at the facility:

- The biological treatment facility (BTF), designed to treat wastewater generated at the facility, was constructed in 1973-74, first received wastewater in 1975 and is still in operation today. SMA 1 includes the BTF Process Area.

- Land Disposal Areas (LDAs) have been used at various times over the life of the facility. Biological sludge, blast furnace sludge, and construction and demolition debris have been placed in the land disposal areas. SMA 2 includes the LDAs.

- Coke manufacturing has occurred since 1920 and 120 coke ovens continue to operate. SMA 3 includes the Coke Manufacturing Plant.

- Chemical manufacturing began at the facility in 1948 and all chemical manufacturing operations ceased in 2002. In addition, a mineral wool plant which manufactured mineral fiber used in the production of ceiling tile and insulating products was built in late 1947 and was decommissioned in 2010. SMA 4 includes the FCP and the mineral wool piles.

- An iron blast furnace that produced pig iron from iron ore began operation in 1958; blast furnace operations ceased in 1981, and the blast furnace was decommissioned in 1984. SMA 5 includes the Former Pig Iron Foundry (FPIF).

A RCRA Section 3008(h) Administrative Order on Consent (Order) with the effective date of September 24, 2012, was signed by Walter Coke (which ERP Coke has agreed to implement as a condition of its purchase of certain Walter Coke assets) and the EPA. In the 2012 AOC, there are 45 SWMUs, 6 AOCs, and 5 SMAs listed at the facility. This CMS has been prepared for SMA 5.

A human health risk assessment (HHRA) is presented in this CMS. The HHRA was prepared to determine if constituents detected exceed carcinogenic risks of $1E^{-06}$ and/or noncarcinogenic hazard quotients in excess of 1.0 based on certain conservative exposure assumptions. Site media included in the risk assessments included surficial soil and subsurface soil.

In addition, cleanup goals were calculated for constituents that exceeded the carcinogenic and noncarcinogenic risks.

As discussed in the OSWER Directive 9355.0-30 dated April 22, 1991, acceptable risk levels, where the cumulative carcinogenic risks to an individual based on reasonable exposure, can range from 10^{-4} to 10^{-6} as long as the cumulative excess lifetime carcinogen site risk is less than 10^{-4} and the noncancer hazard quotient (HQ) is less than 1. PCSs were calculated for each receptor for each media type with an excess lifetime cancer risk (ELCR) of 10^{-4}, 10^{-5}, and 10^{-6} or a HQ of 3, 1, and 0.1. In order to meet the goal of the cumulative excess lifetime carcinogen site risk being less than 10^{-4} across all media, the analytical samples from each sample media were compared to the calculated PCS with the ELCR of 10^{-5} or a HQ of 1.0. The value for the most conservative receptor (lowest value) for the 10^{-5} target risk level or HQ of 1.0 was selected as the PCS for human health exposure.

No constituents in surface or subsurface soil exceeded the PCSs for an Industrial/Commercial setting based on the results of the HHRA. Thus, the corrective measures identified in this CMS are designed to keep the property from becoming residential in the future.

As part of the CMS, corrective action alternatives were identified, screened, and evaluated in terms of effectiveness, implementability, and cost so the most protective, efficient, and economical remedial alternative could be identified and selected to remediate media that exceeded the calculated PCSs. The two alternatives evaluated are summarized below:

Alternative 1 No Action

The *No Action* alternative assumes that no further remedial action will occur at the site and has been included to establish a baseline for alternative comparison.

Alternative 2 Physical, Legal, and Administrative Barriers (Land Use Controls)

The *Physical Barrier, Legal Barrier, and Administrative Barrier* (Institutional Control) alternatives consist of administrative and physical mechanisms to place restrictions on the use of and limit access to the site and/or specific SWMUs/AOCs to prevent exposure to site contaminants.

Based on the conclusions of the detailed analysis that was performed individually and collectively with respect to the two alternatives, one alternative was recommended to address potential contamination of the impacted media. The selected alternative is listed below:

Alternative 2 Physical, Legal, and Administrative Barriers (Land Use Controls)

The *Land Use Controls* alternative would be the most efficient and economical method to meet the Corrective Action Objectives (CAOs) for SMA 5 and provide long-term protection of human health and the environment.

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LIST OF ACRONYMS

ADAF	Age-dependent adjustment factor
ADD	Average daily dose
ADEM	Alabama Department of Environmental Management
AF	Adherence factor
ABS_d	Absorption fraction, dermal
A_R	Surface area of contaminated road segment
AOC	Area of Concern
ANPR	Advanced Notice of Proposed Rulemaking
AT	Averaging time
AUF	Area Use Factors
BCFs	Bioconcentration Factors
BTF	Biological Treatment Facility
BW	Body weight
CA	Chemical concentration in air
CAA	Corrective Action Alternative
CAO	Corrective Action Objective
CAP	Corrective Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulation
CF	Conversion factor
COC	Chemical of concern
COPC	Chemical of potential concern
cm/sec	centimeter per second
CMS	Corrective Measure Study
COC	Contaminant of Concern
COPEC	Constituent of Potential Ecological Concern
CR	Cancer Risk
Cshw	Chemical concentration remaining in shower water
CSM	Conceptual site model
CW	Chemical concentration in groundwater
DA_{event}	Absorbed dose per event
DAD	Dermal absorbed dose
DC	Dietary composition
DI	Daily Intake
DOT	Department of Transportation
DWEL	Drinking Water Equivalency Level
EC	Exposure concentration
Eco SSLs	Ecological soil screening levels
ERAGS	Ecological Risk Assessment Guidance for Superfund
ED	Exposure Duration

EF	Exposure Frequency
EI	Environmental Indicators
ELCR	Excess lifetime cancer risk
ERA	Ecological risk assessment
ERAGS	*Ecological Risk Assessment Guidance for Superfund*
ET	Exposure Time
EPC	Exposure point concentration
ERA	Ecological risk assessment
EV	Event frequency
FA	Fraction of chemical absorbed
FMC	Five Mile Creek
FPIF	Former Pig Iron Foundry
F_D	Dispersion correction factor
F_W	Flow rate, water
FI	Fraction Ingested
FWI	Facility Wide Investigation
GPRA	Government Performance Results Act
HDPE	High-Density Polyethylene
HHRA	Human Health Risk Assessment
HHRE	Human Health Risk Evaluation
HI	Hazard index
HQ	Hazard Quotients
IM	Interim Measures
IR	Ingestion rate
IRIS	Integrated Risk Information System
IUR	Inhalation unit risk
Kp	Dermal permeability coefficient in water
LDA	Land Disposal Area
LDR	Land Disposal Restriction
LOAEL	Lowest observed adverse effects level
LUCIP	Land Use Control Implementation Plan
MCL	Maximum Contaminant Level
NCEA	National Center for Environmental Exposure
NCP	National Contingency Plan
NIR	Normalized ingestion rate
NOAEL	No observed adverse effects level
NRWQC	National Recommended Water Quality Criteria
Order	Administrative Order on Consent
ORD	Office of Research and Development
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PCS	Preliminary Cleanup Standards

PEF	Particle emission factor
PIF	Pig Iron Foundry
PPRTV	Provisional Peer Reviewed Toxicity Value
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
PVC	Poly Vinyl Chloride
RAGS	Risk Assessment Guidance for Superfund
RBP	Rapid Bioassessment Protocol
RCRA	Resource Conservation and Recovery Act
RCRIS	RCRA Information System
RfC	Reference concentration
RfD	Reference Dose
RFI	RCRA Facility Investigation
RSL	Regional Screening Levels
SA	Skin surface area
SCS	Soil Conservation Service
SERA	Screening Level Ecological Risk Assessment
SF	Slope Factor
SLERA	Screening Level Ecological Risk Assessment
SMA	SWMU Management Area
SPUF	Soil-to-plant uptake factor
SSL	Soil screening level
SVOC	Semi-volatile Organic Compound
SWA	Slag Wool Aggregate
SWMU	Solid Waste Management Unit
T	Total time
TAL	Target Analyte List
TBD	To Be Determined
TCL	Target Constituent List
TCLP	Toxicity Characteristic Leaching Procedure
TRVs	Toxicity Reference Values
TSD	Treatment, Storage, And Disposal
UCL	Upper Confidence Limit
UF	Uptake factor
USEPA	United States Environmental Protection Agency
Va	Volume, bathroom
VDEQ	Virginia State Department of Environmental Quality
VF	Volatility factor
VI	Vapor Intrusion Study
VISL	Vapor intrusion screening calculator
VOC	Volatile Organic Compounds

Corrective Measures Study
SMA 5 – Former Pig Iron Foundry
ERP Coke
3500 35th Avenue North
Birmingham, Alabama

Project No. E1147106
April 14, 2017

1.0 INTRODUCTION

The ERP Compliant Coke, LLC (ERP Coke) facility is located at 3500 35th Avenue North in Birmingham, Jefferson County, Alabama (Figure 1-1). This Corrective Measures Study (CMS) for SMA 5 has been prepared in accordance with paragraph 29 of the Order on Consent with effective date of September 24, 2012. A map of the current facility including the 45 Solid Waste Management Units (SWMUs), six Areas of Concern (AOCs), and five SWMU Management Areas (SMAs) is included as Figure 1-2.

The roots of the facility can be traced back to 1881 when Sloss-Sheffield Steel and Iron Company first began producing pig iron in Birmingham, Alabama. In 1920, where ERP Coke sits today, Sloss-Sheffield Steel and Iron Company built two modern coke oven batteries to serve its own needs as well as those of other customers. As Birmingham's steel industry grew, so did the need for furnace coke, which prompted the construction of three more batteries at the site during the 1950s.

As American industry evolved in the ensuing years, so did the operation of the facility. Today, ERP Coke is a highly efficient, technologically advanced operation serving a variety of customers in the furnace and foundry markets.

The operation now consists of three batteries with a total of 120 coke ovens which produce approximately 460,000 tons of coke each year. A highly experienced operating staff provides assurance of adherence to strict operating, environmental, and safety standards.

The original coke manufacturing facility began operation in 1920 as Sloss Sheffield Steel and Iron Company. Beginning in 1952, the company experienced a series of corporate reorganizations and several name changes culminating in a name change to Walter Coke, Inc. in May 2009, and then the purchase of the coke plant assets by ERP Compliant, Coke, LLC in February 2016. The following operations have occurred at the facility:

- The biological treatment facility (BTF), designed to treat wastewater generated at the facility, was constructed in 1973-74, first received wastewater in 1975 and is still in operation today. SMA 1 includes the BTF Process Area.

- Land Disposal Areas (LDAs) have been used at various times over the life of the facility. Biological sludge, blast furnace sludge, and construction and demolition debris have been placed in the land disposal areas. SMA 2 includes the LDA.

- Coke manufacturing has occurred since 1920, and 120 coke ovens continue to operate. SMA 3 includes the Coke Manufacturing Plant.

- Chemical manufacturing began at the facility in 1948, and all chemical manufacturing operations ceased in 2002. In addition, a mineral wool plant, which manufactured mineral fiber used in the production of ceiling tile and insulating products, was built in late 1947 and was decommissioned in 2010. SMA 4 includes the FCP and the mineral wool piles.

- An iron blast furnace that produced pig iron from iron ore began operation in 1958; blast furnace operations ceased in 1981, and the blast furnace was decommissioned in 1984. SMA 5 includes the Former Pig Iron Foundry (FPIF).

The land around the ERP Coke facility is zoned for industrial and residential use, and a significant number of other industrial facilities remain operational in the area. Before 1957, the area was primarily industrial, with a significant number of other facilities, including coke and cement manufacturing plants, pipe manufacturing plants, and limestone quarry operations. Residential neighborhoods were constructed on properties in the area of ERP Coke only after 1957 (USEPA, 1990). The most likely future land use for the ERP Coke facility is industrial.

1.1 1989 RCRA Order

The following provides a brief chronological overview of key points in the regulatory history associated with the 1989 RCRA Order:

- August 1989 - EPA completed the RCRA Facility Assessment (RFA).
- September 29, 1989 - Section 3008(h) Administrative Order 89-39-R was issued requiring performance of an RFI and a CMS.
- October 24, 1990 – After a challenge to the 1989 Administrative Order, a Modification to the Administrative Order and Settlement Agreement was entered and then governed work at the facility.
- 1990 to 1994: Planning for the RFI to characterize the nature, extent, and rate of contaminant migration from the identified SWMUs was submitted, and a draft RFI Work Plan was submitted to EPA for review and approval.

- The RFI Work Plan, which outlined an approach for investigating the 39 SWMUs, was approved by EPA in 1994.
- 1995 and 1996 – A Facility-Wide Investigation (FWI) was completed to develop a conceptual hydrogeologic and hydrologic model of the facility.
- 1996 to 1999 – Numerous RFI field investigations were conducted and reports submitted to EPA.
- 2000 to 2001 – Phase II field investigations were conducted.
- 2002 – Interim Remedial Measures (IM) Work Plan for the Chemical Plant was submitted to EPA.

In an effort to help EPA complete its environmental indicator (EI) determinations for the site and thereby help EPA meet its Government Performance Results Act (GPRA) goal to show that human exposures and groundwater releases were controlled by September 30, 2005, the following activities that are specific for EI determination were completed:

- February 2005 –Proposed EI Sampling Plan submitted.
  - March 2005 – EPA approved the EI Sampling Plan.
- July 2005 - Consolidated Overview of Environmental Data in Support of the EI Determination submitted.
  - September 30, 2005 – EPA issued the final EI evaluation of the facility's status in relation to RCRA Information System (RCRIS) CA Codes 725 and 750. The CA 725 decision was noted as "Yes"; the CA 750 decision was noted as "No".
  - March 16, 2012 - EPA issued another EI evaluation of the facility's status in relation to RCRA Information System (RCRIS) CA Codes 725 and 750. The CA 725 decision was noted as "No"; the CA 750 decision was noted as "No".

Following the completion of the EI activities, EPA and ERP Coke focused on the next phase of RFI activities.

- 2006 – EPA issued technical comments on several RFI reports.
- 2007 – Phase III RFI Work Plan was prepared and approved by EPA.
- 2009 –Draft Phase III RFI Report submitted.
  - June 2009 –Addendum to the Phase III report submitted.

1.2 2012 RCRA Order

Pursuant to EPA's stated desire to update the 1989 Order, Walter Coke and EPA entered a RCRA Section 3008(h) Administrative Order on Consent (AOC) with the effective date of September 24, 2012. The 2012 AOC declared that all of the approved investigation tasks of the RCRA Facility Investigation (RFI) Work Plans required by the 1989 Order had been completed and that the 1989 Order was terminated and no longer in effect. Under the 2012 AOC, there are 5 SMAs consisting of 45 SWMUs and 6 AOCs at the facility (Figure 1-2). In February 2016, ERP Coke purchased certain assets of Walter Coke, Inc., including the coke plant, in a transaction in which ERP Coke agreed to implement the 2012 AOC.

As part of the Order, a CMS is being prepared for each of the 5 SMAs to evaluate the need, if any, for corrective measures. The scheduled completion date for each CMS is:

- CMS SMA 1 – Previously submitted to EPA on May 24, 2013. (Revision 1.1 submitted to EPA on January 24, 2014)
- CMS SMA 2 – Previously submitted to EPA on July 22, 2013
- CMS SMA 3 – Previously submitted to EPA on September 24, 2013
- CMS SMA 4 – Previously submitted to EPA on March 24, 2014 (Revision 1.0 submitted to EPA on April 14, 2017)
- CMS SMA 5 – Previously submitted to EPA on September 24, 2014. (Revision 1.0 submitted September 30, 2015 and Revision 1.1 is this submittal)

1.3 Corrective Measures Study (CMS) Overview

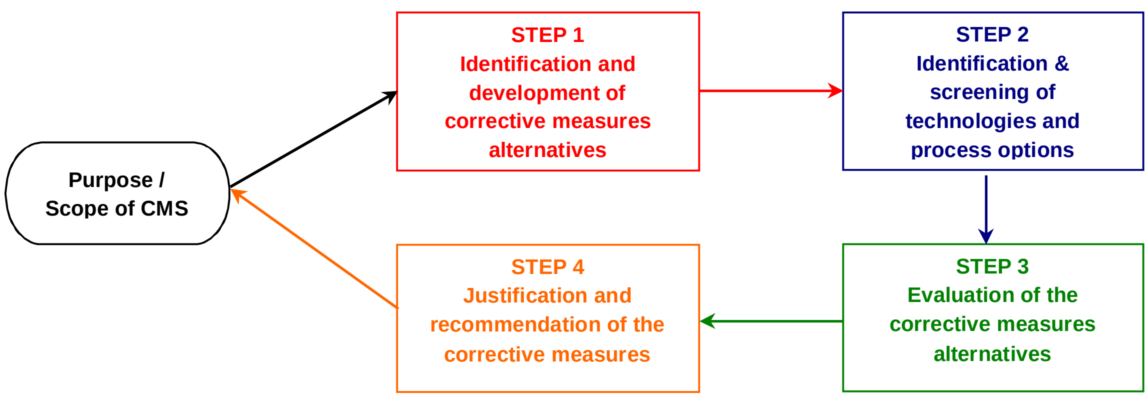
The CMS is the portion of the RCRA corrective action process designed for the identification and evaluation of potential remedial alternatives for conditions that have been documented at a facility (USEPA, 1994). Once properly evaluated with respect to criteria such as overall protectiveness, effectiveness, and costs, risk managers should have sufficient information to select and initiate the implementation of remedies, if any.

The purpose of this CMS Report is to summarize the evaluation, analysis, and selection of appropriate corrective action at SMA 5. SMA 5 consists of three SWMUs and one AOC (Figure 1-3). They include:

- SMWU 43 – Pig Machine Slurry Pits
- SWMU 44 – Blast Furnace Ash Boiler Pit
- SWMU 45 – Slag Drying Beds
- AOC C – Former Pig Iron Foundry

This CMS has been prepared to identify remedial alternatives identified for SMA 5. As part of the CMS activities, a Risk Assessment Work Plan (Revision 1.1) was submitted to EPA on March 6, 2013. The Risk Assessment Work Plan was approved by EPA on March 15, 2013. In accordance with that Plan, the Risk Assessment prepared as part of this CMS, will consider risk in SMA 5 and clean up goals for various constituents present in SMA 5. The CMS will also identify and compare remedial alternatives for certain affected media present in SMA 5. A comprehensive Microsoft Access database provided to Terracon by CH2MHILL was reviewed to determine previous analytical data collected within SMA 5. Based on our database review, no sampling had been previously conducted in SMA 5; therefore surface and subsurface soil sampling was conducted as part of this CMS. Monitoring wells located around SMA 5 and associated with the other SMAs did not indicate any groundwater contamination emanating from SMA 5; therefore, groundwater sampling was not conducted during the CMS. Groundwater contamination located in other areas of the facility are being addressed under the other CMS reports previously submitted. The Risk Assessment being performed during the CMS process derives and characterizes potential risks to human health and the environment. Carcinogenic risks in excess of 1E-06 and/or noncarcinogenic hazard quotients in excess of 1.0, were used to delineate areas and volumes of affected media, and corrective action alternatives were developed and evaluated as possible site cleanup remedies. This CMS focuses primarily on addressing the potential risks posed to site receptors from exposure to contaminants at SMA 5.

Four fundamental phases or steps, as shown in the diagram below, are inherent to the development of any CMS. Once these steps are defined, a wide range of options exist for structuring and refining a CMS to meet the specific goals, objectives, and regulatory requirements associated with a given project site. Based on the RCRA Corrective Action Plan, OSWER Directive 9902.3-2d (May 1994), Chapter IV – Corrective Measures Study, this CMS Report was prepared according to the following steps:



1.4 Site Description

The ERP Coke facility is located at 3500 35th Avenue North in Birmingham, Jefferson County, Alabama, as shown on Figure 1-1. This active coke production facility encompasses an area of approximately 460 acres. SMA 5 is located on the southeastern end of the facility, as shown on Figure 1-2.

SMA 5 comprises the FPIF. SMWU 43 – Pig Machine Slurry Pits held the water used to cool the pigs after production and this water was recycled back to the pits and circulated. SWMU 44 – Blast Furnace Ash Boiler Pit was used to store coal ash for cooling prior to disposal. SWMU 45 – Slag Drying Beds are concrete structures where slag was placed for cooling and drying. AOC C – Former Pig Iron Foundry is the portion of the facility where pig iron was manufactured.

1.5 Environmental Setting

1.5.1 Surface Water Bodies

There are no surface water bodies located in the vicinity of SMA 5.

1.5.2 Bedrock Geology

The facility is underlain by sedimentary rocks that range in age from Cambrian to Pennsylvanian. The Opossum Valley Fault generally trends northeast to southwest, crossing through the ERP Coke property in the northern portion of the facility at SWMU 22. The majority of the ERP Coke property lies on the hanging wall fault block to the east of the Opossum Valley Fault. The foot wall of the fault lies to the west and underlies Sand Mountain. The majority of the ERP Coke property is underlain by the Conasauga Formation. The Red Mountain Formation, Fort Payne Formation, Tuscumbia Limestone, Hartselle Sandstone, Floyd Shale, and Pottsville Formation outcrop in the small area of the facility on the western side of the fault on the north side of the facility. A Geologic Map is included as Figure 1-4. Cross Sections provided in the CH2MHILL Phase III RFI are included as Figures 1-5 through 1-7.

The Conasauga Formation is Cambrian Age and typically is medium gray, thin- to medium-bedded limestone. Locally, bedding thickness is reported to range from a few inches to as much as 5 feet or more in the massive sections. Massive bedding sections are rare and bedding thicknesses less than 1 foot are common. Locally, the Conasauga Formation dips to the southeast at 26 to 32 degrees, with a strike of approximately N45°E. An extensive network of faults and joints has developed in the Conasauga Limestone because of thrust faulting. The faults and joints typically trend northeast and northwest. The northeast trending joints (strike of N45°E) dip approximately 60°NW (approximately perpendicular to bedding), while the northwest trending joints strike N300W and have subvertical dips. The results of previous investigations indicate that the upper 2 feet of the Conasauga Formation underlying the ERP Coke facility are highly weathered. Below the weathered surface, the limestone is generally massive, with few fractures. The limestone is typically hard, with 1- to 2-foot-thick lenses of softer, darker gray shale and shaley limestone. Occasionally, fractures are present, ranging from a few inches to a few feet thick. Fracture zones typically contain limestone rubble that exhibits secondary healing by calcite crystals. Fracture zones typically are encountered in the upper 50 feet of the formation and are less frequent with increasing depth.

On the western side of the Opossum Valley Fault (in the SWMU 22 area), outcrops of the Hartselle Sandstone, Tuscumbia Limestone, Fort Payne Chert, Red Mountain Formation, and Pottsville Formation have been mapped. Brief descriptions of these units are provided below:

- Hartselle Sandstone – composed mainly of clean, well-sorted, light-colored, very fine- to medium-grained quartz sand;

- Tuscumbia Limestone – consists of thick-bedded, medium-dark to medium-gray, crystalline, oolitic, sublithographic, and bioclastic limestone with minor amounts of chert;
- Fort Payne Chert – consists of dark-gray sublithographic limestone and dense dark-gray chert;
- Red Mountain Formation – consists of dark-reddish-brown to olive-gray siltstone, sandstone, and shale with hematite beds;
- Pottsville Formation – characterized by alternating beds of sandstone and shale with numerous coal seams and associated underclays.

The topography of the bedrock underlying the facility generally slopes to the north toward Five Mile Creek (FMC). Top-of-bedrock elevations range from 583.1 feet above mean sea level (amsl) in the Coke Plant area to 498.6 feet amsl near FMC. Weathering of the Conasauga Formation has produced undulations in the surface of the bedrock. Several feet of relief have developed on the bedrock surface. This relief is as much as several tens of feet in some areas of the property; however, karst features are not evident at the ground surface. Where exposed, enlargement of bedding planes and fractures appears to have occurred through solution of the bedrock. Solutionally enlarged fractures and joints primarily are limited to the upper few feet of bedrock and have been observed up to 1 foot wide.

1.5.3 Soils

The majority of the overburden at the ERP Coke facility consists of residual soil from weathered Conasauga Formation (residuum). On and adjacent to Sand Mountain (immediately west and north of SWMU #22), residual soils have formed on the Hartselle Sandstone and the Tuscumbia Limestone. Near the Coke Plant and the FPIF, industrial fill material is present at thicknesses ranging from 0.5 to 6 feet. Similar fill material is present in the BTF area. The overburden ranges in thickness from 2 to more than 20 feet. Native soil over limestone consists of cohesive, medium-stiff to stiff inorganic clays of low to medium plasticity and high plasticity. General engineering properties, as indicated by analytical and visual observations of site soil properties, include high shrink-swell potential, low permeability, and low-strength capabilities.

Near the base of the residuum at the bedrock interface, a zone of more permeable soils has developed, with chert and highly weathered limestone gravels consolidated from the weathering of the underlying bedrock. This area typically is referred to as the rubble zone. Where observed, the rubble zone appears to range up to 2 feet thick. The rubble zone does not appear to be laterally continuous throughout the facility, but may be a significant water bearing zone locally.

1.5.4 Hydrogeology

The conceptual hydrogeologic flow model for the site is composed of residuum groundwater, shallow bedrock groundwater, and deep bedrock groundwater. Groundwater occurs within the residuum where the water table is higher than the bedrock surface. Groundwater flow through this material occurs in interstitial pore spaces between the clay particles at a low rate due to the relatively low permeability. Flow rates may be higher where a concentration of chert gravels at the bedrock surface has occurred. Within the shallow and deep bedrock aquifers, groundwater migrates along fractures and bedding planes both horizontally and vertically. Within the shallow bedrock aquifer, groundwater flow is primarily horizontal due to the interconnectivity of the fractures. Groundwater within the shallow bedrock discharges to surface water bodies such as the Lafarge Quarry, surface drainage ditches, and FMC. Deep bedrock groundwater is anticipated to migrate toward discharge points such as the Lafarge Quarry.

Based on information provided in the Phase III RFI prepared by CH2MHILL, the groundwater monitoring well network at the facility consists of 109 monitoring wells and piezometers. Monitoring wells and piezometers are constructed of 2-inch diameter, Schedule 40 polyvinyl chloride (PVC) casing and screens with a sand pack. Screens are typically 10 feet long with a 0.010-inch slot size. The sand pack typically extends a minimum of 2 feet above the top of the screen, above which a 2-foot bentonite well seal is installed. Neat cement grout, which typically is installed following hydration of the bentonite seal, extends upward to the ground surface. A surface isolation casing, usually 10-inch-diameter steel, typically is installed from the top of bedrock to the ground surface for bedrock monitoring wells at locations where residuum groundwater is encountered.

Monitoring wells can be grouped into four classifications based on the various units they monitor, as described in the following text:

- Residuum monitoring wells are those wells with screens that are completed within the unconsolidated residuum above bedrock or those monitoring wells with screens and sand filter packs that extend above the top of the bedrock (mixed monitoring). Eleven wells have been classified as residuum (or mixed) monitoring wells. Most of these wells are located in the BTF area, primarily surrounding SWMU 13.

- Shallow bedrock monitoring wells have screens completed entirely within the Conasauga Formation, with 10-foot screens generally between 0 and 40 feet below the top of the bedrock surface. These wells are situated in the fractured and weathered upper portions of the Conasauga Formation. There are 78 shallow bedrock monitoring wells.

- Deep bedrock monitoring wells have 10-foot screens completed between 40 and 300 feet below the top of the bedrock surface. These wells are situated in the less fractured and weathered lower portions of the Conasauga Formation, where groundwater flow is significantly slower than that observed in the shallow bedrock aquifer. There are 16 deep bedrock monitoring wells.

- Four monitoring wells have been completed in formations other than the Conasauga Limestone. These non-Conasauga monitoring wells have been installed at SWMU 23, on the western side of the Opossum Valley Fault. They are not completed in the Conasauga Formation and their groundwater elevations are not included in the potentiometric surface maps developed for either the shallow or deep Conasauga Limestone flow zones in the Phase III RFI. These wells have been constructed with 10-foot screens, with total depths ranging from 63 feet to 118.5 feet below ground surface (bgs).

Three potential water-bearing zones are composed of 1) residuum soils and the upper weathered bedrock surface; 2) shallow bedrock (20 to 140 feet bgs); and 3) deep bedrock (140 feet bgs). Water enters the groundwater system in the valley via infiltration of rainfall through the residual soils and lateral migration of groundwater through the residuum and shallow bedrock aquifer. Recharge moves vertically downward until it encounters the rubble zone, where lateral groundwater flow across the bedrock surface may occur. Because of the discontinuous occurrence of groundwater in the residuum (based on observations during the site wide drilling efforts) and the relative lack of site wide residuum monitoring wells, a potentiometric surface map for residuum groundwater has not been developed.

Groundwater flows from the residuum into the shallow bedrock aquifer through fractures and joints in the Conasauga Formation. Within this formation, groundwater flow is controlled by the occurrence and relationships among fractures, joints, and bedding planes of the limestone and shale. These features are interconnected and comprise the dominant feature of the groundwater flow systems, providing flow paths for groundwater migration. Significant water-bearing zones in the Conasauga Formation vary laterally and with depth. The upper weathered bedrock surface, fractures, and soft, shaley zones in the upper 20 feet to 140 feet appear to be hydraulically connected, based on historical water level data.

Although recovery rates are slow for wells completed in the deep Conasauga Formation, water level measurements indicate that the deep zone generally is in hydraulic connection with the more permeable shallow zones of the Conasauga Formation.

Potentiometric surface maps of the shallow and deep bedrock flow zones were developed for the facility during the Phase III RFI using water level measurements collected site wide on April 28 and 29, 2008 by CH2MHILL (Figures 1-8 and 1-9). Groundwater gradients depicted in the shallow bedrock potentiometric surface map, Figure 1-8, indicate that shallow bedrock groundwater generally flows from southwest to northeast toward FMC with local influence from Lafarge Quarry operations. The Lafarge Quarry is anticipated to serve as a discharge point for shallow bedrock groundwater.

Locally, a hydraulic ridge has developed in the shallow bedrock potentiometric surface, trending generally southeast to northwest and extending from P-19S beneath the Coke Plant toward the Former Pig Iron Foundry and MW-55 (a local groundwater high). Near the former Plant, groundwater flows radially away from MW-55. Groundwater appears to flow from the Former Pig Iron Foundry offsite to the east. Along the southern boundary of the ERP Coke facility, shallow bedrock groundwater appears to flow to the southeast. Groundwater elevations in the residuum in the BTF area are as much as 10 feet higher than those recorded in the shallow bedrock aquifer, indicating recharge of the shallow bedrock aquifer by residuum groundwater.

The inferred groundwater flow direction (based on groundwater gradients) in the deep bedrock aquifer is generally eastward across the facility (Figure 1-9). At the northern end of the facility near the BTF, there may be deviations in the flow direction to the northeast, whereas at the southern end of the facility near the Coke Plant, there may be deviations to the southeast. A steep gradient is noted around the Lafarge Quarry, which exerts a local effect on the potentiometric surface through groundwater extraction. Deep bedrock groundwater likely discharges to the Lafarge Quarry to the east. The pumping of water from the quarries has created hydraulic sinks in the deep bedrock aquifer, causing deep bedrock groundwater to flow to the east.

1.5.5 Ecological Setting

ERP Coke is a large, active, industrialized facility. Generally, the southern three fourths of the property is occupied by buildings and structures associated with the coke manufacturing process, the FPIF, as well as raw materials (coal), roads, railways, and active large vehicles (rail cars). The only area on the facility where industrial activity is less extensive is at the northern end, which is occupied by the active BTF and various land disposal areas that have been relatively undisturbed in recent years. Terrestrial and aquatic habitats in this area are supportive, to varying degrees, of populations of terrestrial and aquatic plants and animals. FMC, which is immediately north of the facility boundary, receives treated wastewater discharge via ERP Coke’s NPDES-permitted outfall. FMC has a U.S. Fish and Wildlife Service (USFWS) designated water use; thus, the water quality in this stream is to be maintained for fish and wildlife.

1.5.5.1 Terrestrial Habitats

Terrestrial habitats are present at this facility and support a variety of plants, as well as various invertebrates, birds, and mammals. The terrestrial habitats are dominated by grasses, scrub-shrub, vines, saplings, and deciduous trees. Wildlife noted on the site includes several bird species (hawks, vultures, sparrows, and songbirds), small mammals (rabbits, foxes, and beavers), and frogs. SWMUs that have terrestrial habitat include SWMUs 23, 24, 25, 38, 39, 40, and 41. The BTF, located at the northern end of the facility, is characterized by a wooded area surrounding SWMUs 23, 40, and 41, the open scrub-shrub area of SWMU 24, and maintained grasses throughout the developed process areas. Surrounding SWMU 25 from the western edge of SWMU 38 to the property boundary to the west, the property is characterized as a riparian zone. SWMUs 38 and 39 are characterized as disturbed land containing low-diversity vegetation. The southern areas of the property, which are highly industrialized, contain no terrestrial habitat supportive of plant or wildlife communities. None of the SWMUs described above are located within the boundaries of SMA 5.

1.5.5.2 Aquatic Habitats

Aquatic habitats are present at SWMUs 13, 22, and 25, as well as at FMC, and support a variety of plants, invertebrates, fish, birds, and small mammals. Wetland areas have developed in storm water collection areas such as the southern end of SWMU 22. The SWMU 40 and SWMU 22 discharge into FMC via an outfall area at the northern end of the BTF. Evidence of aquatic flora and fauna, including cattails, willows, soft rushes, water oaks, frogs, small- and large-bodied fish species, and macroinvertebrates, can be found in the aquatic habitats onsite and in adjacent FMC. None of the SWMUs described above are located within the boundaries of SMA 5.

1.6 Evaluation of Previous Data from the SWMUs and AOCs in SMA 5

Previous sampling was not conducted in SMA 5; therefore, surficial soil sampling and subsurface soil sampling was conducted as part of this CMS. The soil sampling program is described in Section 2.0.

1.6.1 FPIF Area

The FPIF consists of SWMUs 43, 44, 45, and AOC C. A description of the processes in FPIF is included in Section 1.4. Soil samples were collected from a total of 10 locations designated SB43001 through SB43003, SB44001 through SB44003, and SB45001 through SB45004 during the preparation of this CMS. A summary of the Analytical Results are presented in Appendix A. There were no groundwater wells located in SMA 5. Monitoring wells surrounding SMA 5 were associated with other SMAs. Based on groundwater sampling conducted around SMA 5 during previous investigations, there has been no indication that groundwater has been impacted by SWMUs located within SMA 5.

A Baseline Human Health Risk Assessment (HHRA) was performed for the surface soil and subsurface soil in SMA 5. The HHRA is presented in Section 3.0, and the tables associated with the HHRA are presented in Appendix B.

2.0 SOIL SAMPLING PROGRAM

Soil sampling was not previously conducted in SWMU 43, SWMU 44, or SWMU 45; therefore, a soil sampling program was conducted to obtain representative surface soil (0-1 foot depth interval, where possible) and subsurface soil.

2.1 Soil Sample Collection and Headspace Screening

On June 16 and 17, 2014, Terracon advanced three soil borings (designated SB43001 through SB43003) in SWMU 43, three soil borings (designated SB44001 through SB44003) in SWMU 44, and four soil borings (designated SB45001 through SB45004) in SWMU 45, using a hollow-stem auger rig. The soil boring locations are shown on Figure 2-1. Boring logs are included as Appendix C.

Prior to initiation of drilling and between boreholes, the hollow-stem augers and the split-spoons were steam cleaned. An equipment blank was collected each day to provide quality assurance that the sampling equipment was adequately cleaned. Field blanks and trip blanks were submitted to the laboratory for analysis with the soil samples to provide quality assurance that external contaminants were not introduced into the samples during collection or transport.

Oversight of advancement of these boring was conducted by a Terracon geologist, Mr. Eric Reardon. The soil samples were collected utilizing two-foot long, stainless steel split spoons and a hydraulic hammer. Surficial samples were collected from the 0-1 foot depth interval. Subsurface soil samples were collected at two-foot intervals (1-3, 3-5, etc.) below the surface soil intervals using split-spoon samplers. Soil samples were collected until split-spoon and hollow-stem auger refusal (bedrock) or groundwater was encountered.

A representative portion of the sample interval was collected into labeled, laboratory-provided, glass jars with Teflon-lined lids for possible submission to the analytical laboratory. The remainder of the sample was collected in a resealable, plastic bag for volatile organic vapor headspace screening. The headspace screening samples were heated for at least 20 minutes to allow volatile organics in the soil to release vapor into the bag. The amount of volatile organic vapor in the headspace was measured with a Thermo Environmental Instruments, Inc. Model 580B Organic Vapor Meter (OVM). OVM readings ranged from less than 1 part per million (ppm) to 3.2 ppm. Up to three soil samples per boring were submitted to the laboratory for analysis: the soil sample from the interval immediately above the water saturation zone, where possible, and two additional soil samples based on field conditions.

All soil samples were submitted under chain-of-custody to TestAmerica in Arvada, Colorado, for analysis of volatile organic compounds (VOCs) per USEPA Method 8260B, semi-volatile organic compounds (SVOCs) per USEPA Method 8270D, and polynuclear aromatic hydrocarbons (PAHs) per EPA Method 8270CSIM.

2.2 Data Review and Validation

The laboratory conducted an initial data review and validation according to the laboratory QA manual. Data validation included application of data qualifiers to the analytical results based on adherence to method protocols and QA/QC limits. A discussion of applied data qualifiers is included within the case narrative of the analytical report for each sample delivery group. Data meeting *analytical* validity requirements set by the analytical method and the fixed-laboratory were further reviewed against the project-specific DQOs. This data validation was performed by a qualified Terracon professional outside of the project implementation chain-of-command, in accordance with the Terracon Corporate Quality Program Manual and this project's DQOs.

Items reviewed included the following components:

- Completeness Check;
- Chain of Custody (signatures, sample conditions, preservatives, sampling handling/filtering);
- Holding Times;
- Random check (10-20%) of Initial and Continuing Calibration;
- Review of Quality Control Summaries including negative control (blanks) and positive control (LCS);
- Review of Sample Specific Controls (replicates, matrix spikes, surrogates, tracers/ yields);
- Overall PARCC assessment.

Data quality assessment (DQA) criteria were used to evaluate the quality of the field sampling efforts and laboratory results for compliance with project DQOs. The DQA criteria are expressed in terms of analytical precision, accuracy, representativeness, completeness, and comparability (PARCC).

Precision: is a measure of the reproducibility of analyses under a given set of conditions compared to the criteria of the individual laboratory's Quality Assurance Manual.

Matrix precision is calculated using equation (1).

$$RPD = \frac{|D_1 - D_2|}{(D_1 + D_2)/2} \times 100, \quad (1)$$

where,
RPD = Relative Percentage Difference
D1 = First sample value
D2 = Second sample value (duplicate)

An RPD within the method-specific control limit indicates satisfactory precision in a measurement system. For these sampling events, duplicate results were predominantly in control.

Accuracy: is a measure of the bias that exists in a measurement system compared to the criteria of the individual laboratory's Quality Assurance Manual.

For accuracy analysis; the percent recovery is calculated using equations (2) and (3).

$$LCS = \frac{Amount\ of\ Spike\ Analyte\ Detected}{Known\ Amount\ of\ Spike\ Analyte\ Added} \times 100, \quad (2)$$

LCS = Laboratory Control Sample

$$MS\ (or\ MSD) = \frac{Total\ Amount\ of\ Analyte\ Detected - Amount\ of\ Analyte\ Detected\ in\ Sample}{Known\ Amount\ of\ Spike\ Analyte\ Added} \times 100 \quad (3)$$

MS (or MSD) = Matrix Spike (or Matrix Spike Duplicate)

Accuracy results for methods and matrices are predominantly in control. For those results in which MS/MSD were out of control; accuracy and precision were generally demonstrated by acceptable LCS/LCSD analysis. Therefore, overall accuracy for these sampling events was acceptable.

Representativeness: Sample data are believed to accurately depict selected site conditions prevailing at the time of sample collection based on a general conformance to established protocols as established by TSOPs, laboratory QA/QC protocol, and/or USEPA/ADEM standard operating procedures.

Comparability: Samples were reported in industry-standard units. Water reporting units were micrograms per liter (µg/L) or milligrams per liter (mg/L). Analytical protocols for the methods were adhered to (with the exceptions noted in the reports) and analytical results are considered comparable.

Completeness: the measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under "normal" conditions. This goal will be accomplished if 95% of design samples are taken and found to be qualified for precision and accuracy. Completeness objectives were met, understanding that results qualified with U, UJ or J are usable to meet the project objectives of these sampling events.

The soil data are of acceptable quality and are considered usable to support the project objectives for this sampling event when used in accordance with the validation qualifiers. The laboratory data will be submitted electronically to EPA Region 4 per the steps found on http://www.epa.gov/region4/superfund/allresource/edd/edd.html.

2.3 Soil Boring Sample Analytical Results

Summaries of the soil sample analytical results are presented on Tables 1 and 2 in Appendix A. The soil sample results were used in the site-specific baseline human health risk assessment (HHRA) found below in Section 3.0. The results of the soil sample analytical data are as follows:

2.3.1 VOC Analysis

The following VOCs were detected in at least one sample at concentrations exceeding the RSL from the listed soil borings:

- Acetone – SB43001, SB43003
- Benzene – SB44001
- Ethylbenzene – SB44001
- Isopropylbenzene – SB44001
- m&p xylene – SB44001, SB44003
- o-xylene – SB44001, SB44003
- Toluene – SB44003

2.3.2 SVOC Analysis

The following SVOCs were detected in at least one sample at concentrations exceeding the RSL from the listed soil borings:

- Acenaphtene – SB43002, SB44001, SB45003
- Acenaphthylene – SB43001, SB43002, SB43003, SB44001, SB45001, SB45003
- Anthracene – SB44001, SB45001, SB45002, SB45003, SB45004
- Benzo(a)anthracene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002
- Benzo(a)pyrene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002
- Benzo(b)fluoranthene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Benzo(g,h,i)perylene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002
- Benzo(k)fluoranthene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002
- Carbozole – SB44001
- Chrysene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003
- Dibenz(a,h)anthracene SB43003, SB44001, SB44003, SB45001, SB45002
- Dibenzofuran – SB44001

- Fluoranthene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003
- Fluorene –SB44001
- Ideno(1,2,3-cd)pyrene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002
- Naphthalene –SB44001, SB45004
- Phenanthrene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003
- Pyrene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003
- 2-Methylnaphthalene – SB43002, SB44001

2.3.3 PAH SIM Analysis

The following PAH SIM were detected in at least one sample at concentrations exceeding the RSL from the listed soil borings:

- Acenaphtene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Acenaphthylene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Anthracene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Benzo(a)anthracene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Benzo(a)pyrene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Benzo(b)fluoranthene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Benzo(g,h,i)perylene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Benzo(k)fluoranthene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Chrysene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Dibenz(a,h)anthracene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Fluoranthene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Fluorene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004

- Ideno(1,2,3-cd)pyrene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Naphthalene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Phenanthrene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Pyrene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- 2-Methylnaphthalene – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004

2.3.4 RCRA Metals Analysis

The following RCRA metals were detected in at least one sample at concentrations exceeding the RSL from the listed soil borings::

- Arsenic – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003
- Barium – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Cadmium – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001
- Chromium – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Lead – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003, SB45004
- Selenium – SB43001, SB43002, SB43003, SB44002, SB45002, SB45003, SB45004
- Silver – SB43001, SB43002
- Zinc – SB43001, SB43002, SB43003, SB44001, SB44002, SB44003, SB45001, SB45002, SB45003

2.4 Groundwater Leachability

Site Specific Soil Screening Levels (SSLs) for leaching to groundwater were presented in Appendix G of the Phase III RFI prepared by CH2MHILL. The basis of the approach is that infiltrating precipitation leaches chemicals from the soil and transports the chemicals to the uppermost groundwater. The leachate is then diluted by the lateral flow within the groundwater-bearing unit. The approach assumes that a hypothetical future groundwater user is present on the immediate downgradient boundary of the site. Potable groundwater use is assumed for the hypothetical future scenario.

A statistical analysis was performed on the soil data collected from the 0-9 ft depth interval. The SSLs were compared to the 95% UCL concentration. If a UCL could not be calculated due to a lack of detections, the then maximum concentration was used as a comparison against the SSL. The results of the screening are presented in Table 2-1.

1,2,3-trichlorobenzene and isopropylbenzene maximum concentrations exceeded the SSLs; however, there were too few detections to calculate a 95% UCL so the chemicals were deemed to fail the SSL screening. Further consideration should be given to these chemicals as there were very few detections, and it is likely that these chemicals do not pose a threat to groundwater from leaching.

The following chemicals had a 95% UCL that failed the comparison to the SSLs: benzene; benzo(a)anhracene; benzo(b)fluoranthene; carbazole; dibenz(a,h)anthracene; dibenzofuran; indeno(1,2,3-cd)pyrene, naphthalene, arsenic, and chromium.

SSLs are inherently conservative estimates that are based on a number of assumptions including:

- The SSL evaluation assumes that there is uniform distribution of COCs across an entire “site” and that groundwater is or could be used on the immediate downgradient edge of the site.
- No degradation of the chemicals is included as the chemicals are transported vertically through the vadose zone or lateral transport in the groundwater bearing unit.
- The leaching of chemicals from soil are dependent on chemical and site specific physical conditions. Leachate concentrations can either be over or underestimated.
- The initial screening of chemicals assumes an infinite source mass and therefore may violate mass limit constraints.

Groundwater sampling was conducted on monitoring wells surrounding SMA 5 during previous investigations. Based on the Phase II RFI, none of the groundwater samples including those at the downgradient edge of SMA 5 exhibited concentrations of the constituents listed above in excess of the EPA screening values for tap water or the MCL. Therefore, it was determined that groundwater sampling was not needed in SMA 5.

3.0 BASELINE RISK ASSESSMENT SMA 5

The purpose of this Baseline Risk Assessment is to provide an analysis of the potential adverse health effects (current and future) caused by hazardous substance releases from a site in the absence of any actions to control or mitigate these releases (i.e., under an assumption of no action) at SMA 5. The baseline risk assessment contributes to the site characterization and subsequent development, evaluation, and selection of appropriate response alternatives. The results of the baseline risk assessment are used to help determine whether additional response action is necessary at the site, to modify preliminary remediation goals, to help support selection of the "no- action" remedial alternative, where appropriate, and to document the magnitude of risk at a site, and the primary causes of that risk (USEPA, 1989). Sections 3.1 through 3.7 comprise the Baseline Human Health Risk Assessment (HHRA). The tables for Section 3.0 are located under the Tables tab at the back of this report.

3.1 Overview of the Human Health Risk Assessment (HHRA)

The purpose of this Baseline HHRA is to evaluate the potential adverse effects to humans that may result from exposure to chemicals in the environment at SMA 5. The overall risk assessment approach for the HHRA follows the USEPA's standard, four-step human health risk assessment paradigm, including: Hazard Identification, Exposure Assessment, Toxicity Assessment, and Risk Characterization. These steps are performed according to methodology and procedures published by USEPA in various guidance documents and databases, including (but not limited to):

- USEPA's *Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A)* (1989)
- USEPA's *RAGS Part E, Supplemental Guidance for Dermal Risk Assessment (*2004)
- USEPA's *RAGS Part F, Supplemental Guidance for Inhalation Risk Assessment (*2009)
- USEPA's *RAGS Part B, Development of Risk-Based Preliminary Remediation Goals* (1991)
- USEPA's Human Health Evaluation Manual, Supplemental Guidance, Update of Standard Default Exposure Factors (2014)
- USEPA's *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (2002)
- USEPA's *Regional Screening Levels (RSLs)* (June 2015)
- USEPA's on-line toxicity database, *Integrated Risk Information System (IRIS)*

Specific subtasks performed for this HHRA include:

- Data Collection, Evaluation, and Selection of Chemicals of Potential Concern
- Exposure Assessment
- Toxicity Assessment

- Risk Characterization
- Uncertainty Analysis
- Derivation of Remedial Goal Objectives

Descriptions presented below summarize procedures and methodologies utilized to accomplish each of the subtasks of the bullet list above.

3.2 Data Collection, Evaluation, and Selection of Chemicals of Potential Concern

Recent analytical data from soil samples collected from 1- to 2-ft increments, to a depth of 9-ft, were utilized in this HHRA. The soil samples were collected and analyzed during the months of June of 2014; hence, the analytical data are representative of current site conditions. Only soil data are evaluated in this HHRA, as there are no surface water bodies on this SMA (for surface water or sediment exposure), and impacted groundwater is not deemed to be a concern for this SMA. Site groundwater has been fully documented and evaluated on the previously completed SMA HHRAs. Analytical results are presented in Appendix A.

Soil analytical data were grouped into two populations: 0- to 1-ft depth for surface soil evaluations and 0- to 9-ft depth for subsurface soil evaluations.

Chemical data are summarized and tabulated to show pertinent sample statistics for each soil population, including: the minimum and maximum concentrations; the appropriate upper confidence limit (UCL) about the mean; and frequency of detection.

Chemicals of potential concern (COPCs) are chemicals retained for quantitative evaluation in the risk assessment as they may present health threats to receptors. COPCs were selected using the screening criteria as described in RAGS Part A (USEPA, 1989) for all chemicals detected at least once. For selection of soil COPCs, USEPA industrial exposure Regional Screening Levels (RSLs) (USEPA, June 2015) were used to screen for COPCs by comparing the maximum detected chemical concentrations to the more conservative of the cancer effects RSL, at the 1E-06 level, or the noncancer effects RSL, at the 0.1 HQ level, whichever was less. This screening approach ensures that a conservative approach to COPC selection has been performed. COPCs selected for SMA 5 soil are presented in Table 3-1 for surface soil and Table 3-2 for subsurface soil.

3.3 Exposure Assessment

The objectives of the exposure assessment are to characterize potentially exposed human receptors at the Site, to identify actual or potential exposure pathways, and to quantify the potential exposure. Thus, the exposure assessment involves several elements, including:

- Identification of the potential receptors/exposure scenarios (as shown in the Conceptual Site Model [CSM])
- Identification of exposure routes (also in the CSM)
- Quantification of exposure point concentrations (EPCs)
- Identification of the exposure models and assumptions used to calculate daily intakes or doses

3.3.1 Receptors and Pathways Evaluated

The CSM is a schematic representation of the contaminant source; the release mechanisms and environmental transport media; potential exposure routes; and potential receptors. The purpose of a CSM is to provide a framework for problem definition, identify potentially complete exposure pathways that may result in receptor risks, identify data needed to evaluate potential exposure pathways, and help identify effective cleanup measures, if necessary, that would be targeted at significant contaminant sources and exposure pathways. Figure 3-1 presents the CSM for SMA 5 soil, depicting the path a contaminant follows from its release in the environment to intake by the receptor. The results of the CSM illustrate which exposure pathways are complete and will be quantitatively evaluated, as discussed further below.

<u>Current and Future Industrial/Commercial Workers</u>
Current and future industrial/commercial workers are assumed to be adult, full-time workers who may be exposed to on-site contaminants. Industrial/commercial workers are assumed to be long-term employees who work at the facility 40 hours/week, 250 days/year, for a duration of 25 years, and who may be exposed to contaminants in surface soil (0 – 1 ft). Their exposure to soil may be through ingestion, dermal absorption, or inhalation of dust particles. Given the nature of organic contaminants in soil, these workers may also be exposed to volatiles in ambient air.

To summarize, the following pathways are quantitatively evaluated for current and future industrial/commercial workers:

- Soil ingestion
- Soil dermal contact
- Inhalation of soil particles
- Inhalation of VOCs in ambient air

<u>Future Construction Workers</u>
Construction activities may occur on-site, in the future, allowing a construction worker to be exposed to site contaminants. Construction workers may be exposed to chemicals in soil to the depth of a typical building excavation. Construction workers may also be exposed to soil chemicals via dermal absorption or by the inhalation of contaminated dust or VOCs in ambient air. Construction workers are evaluated as potentially being exposed to soils from the surface to a depth of 9 ft.

Construction workers are not assumed to be employees of the facility. Instead, these receptors are assumed to be workers that only visit the site for a project. In this case, the construction project is assumed to have a duration of one year and the construction worker works 40 hours/week.

To summarize, the following pathways are quantitatively evaluated for future construction workers:

- Soil ingestion
- Soil dermal contact
- Inhalation of soil particles
- Inhalation of VOCs in ambient air

Receptors Not Evaluated

As this is an industrial facility, and there is no change in exposure scenario anticipated for the future, residential receptors are not likely to be exposed to site contaminants, and are not evaluated in this HHRA.

Additionally, as this area is a secure industrial facility, it is not anticipated that trespassers (teenagers or other) are likely to be exposed to contaminants in SMA 5, and are not evaluated in this HHRA.

Exposure parameters, including exposure media intakes, frequencies, and durations for each receptor and pathway to be evaluated in this HHRA, are presented in Table 3-3.

3.3.2 Exposure Point Concentrations

An exposure point is a location where a receptor is reasonably assumed to move at random, throughout the duration of exposure, and where contact with an environmental medium is equally likely at all sub-locations. The chemical concentration developed to represent that exposure is termed the exposure point concentration (EPC). Because of the randomness assumed for exposure, an EPC is derived as an estimate of the true arithmetic mean concentration of a chemical in a medium at an exposure location. However, because the true arithmetic mean concentration cannot be calculated with certainty from a limited number of measurements, USEPA recommends that the 95th percentile upper confidence limit (UCL) of the arithmetic mean at each exposure point be used when calculating exposure and risk at that location (USEPA, 1992). Further, if the 95% UCL exceeds the highest detected concentration, the highest detected value is used instead (USEPA, 1989).

USEPA has developed statistical software to aid the development of EPCs for a chemically contaminated site. This software, ProUCL version 5.0.00 (USEPA, 2013a) was utilized to determine the chemical data distributions to provide the most appropriate 95%UCL to serve as the EPC for each environmental medium. Censored data (i.e., non-detect data reported at concentrations below detection limits) were retained and evaluated as described in ProUCL. The EPC selected was either the 95%UCL or the maximum detected concentration, whichever was less. In some cases, ProUCL cannot compute a UCL; for example, with too few sample results or too few detections in a data set. In those cases, the maximum chemical concentration was selected as the EPC. EPCs are presented for the COPCs of SMA 5 surface soil in Table 3-4 and subsurface soil in Table 3.5.

Lead presents a special case for evaluation. It is evaluated in a different manner from the other COPCs, in that the concept of the reference dose (RfD), for noncancer health effects, does not apply. Instead, the probability of adverse health effects from exposure to lead are typically evaluated by using USEPA developed computer models. In the case of lead in soil at SMA 5, it was detected in every 26 sample collected. The maximum concentration of lead in surface soils (0 – 1 ft) was 34 mg/kg, far below the RSL of 800 mg/kg, so it can be eliminated from further evaluation for industrial/commercial workers. The maximum concentration of lead in soils of all depths (0 – 9 ft) is 820 mg/kg. This value slightly exceeds the RSL screening value of 800 mg/kg, so it is reported as a COPC on Table 3.2. However, the lead model typically used to evaluate lead health effects is a probabilistic model, therefore the input parameters used are based on central tendency (i.e., average) values. For the soils of SMA 5 (0 – 9 ft), the average lead concentration is 96.24 mg/kg. This value is approximately seven times lower than the level of concern, 800 mg/kg; hence, lead in soil of SMA 5 is not likely to present a health threat to construction workers, and is not evaluated further in this risk assessment.

Because some EPCs are represented by UCLs as calculated by ProUCL, the printouts from ProUCL are included in Part 1 of Appendix B. Once the EPCs were determined for each soil population, a receptors' chemical intake was calculated, as described below.

3.3.3 Estimating Soil Chemical Intake

Methodology to estimate chemical intake from the various exposure pathways is described further below.

Ingestion

Average daily chemical intake for the incidental ingestion of soil is calculated by use of the following formula (USEPA, 1989):

$$DI_{Ingestion} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

where:

$DI_{Soil\text{-}Ing}$ = average daily chemical intake via soil ingestion (mg/kg-day)

CS = chemical concentration in soil (mg/kg)

IR = ingestion rate (mg soil/day)
CF = conversion factor (10^{-6} kg/mg)
FI = fraction ingested from contaminated source (unitless)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (period over which exposure is averaged, days)

Spreadsheets depicting the calculated chemical intake from ingestion of soil by industrial/commercial workers and construction workers are presented in Appendix B on Tables B1.1 and B1.2, respectively.

Inhalation

For the purposes of evaluating a receptor's exposure to chemicals in ambient air, as either volatiles or adsorbed to dust particles, the development of the exposure concentration (EC) in air, as recommended by USEPA's *RAGS Part F, Guidance for Inhalation Risk Assessment* (USEPA, 2009), must be performed. The EC is calculated by modeling the contaminant concentrations (CA) in air first, following the methodology presented in USEPA's *Soil Screening Guidance* (USEPA, 2002). EC will be determined by using the following equation:

$$EC = \frac{CA \times ET \times EF \times ED}{AT}$$

where:

EC = exposure concentration (µg/m^3)
CA = chemical concentration in air (µg/m^3)
ET = exposure time (hours/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
AT = averaging time (period over which exposure is averaged, days)

The chemical concentration in air (CA) term will be calculated as follows:

$$CA = CS \times [(1 / PEF) + (1 / VF)]$$

where:

PEF = Particle emission factor (m^3/kg); 5.70E+09 m^3/kg (default value) (USEPA, 2002a)
VF = Volatilization factor (m^3/kg).

Additionally, the following equation was used to derive VF, as described by USEPA's *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (*2002).

$$VF = [\ Q/C \times (3.14 \times D_A \times T)^{1/2} \times CF\ ] / (2 \times \rho_b \times D_A)$$

where:

Q/C	=	inverse of mean concentration at center of source (g/m^2-s per kg/m^3)
D_A	=	apparent diffusivity (cm^2/sec)
T	=	exposure interval (sec)
CF	=	conversion factor, 10^{-4} m^2/cm^2
ρ_b	=	dry soil bulk density (g/cm^3) = 1.5 g/cm^3

Additionally, the following equation was used to derive D_A (USEPA, 2002).

$$D_A = [\ (\theta a^{10/3} \times Di \times H') + (\theta w^{10/3} \times Dw) / n^2\ ] / [\ (\rho_b \times K_d) + \theta w + (\theta a \times H')\ ]$$

where:

θa	=	air filled porosity (L_{air}/L_{soil}) = n - θw = 0.284
Di	=	diffusivity in air (cm^2/sec), chemical specific
H'	=	Henry's law constant, unitless, chemical specific
θw	=	water-filled porosity (L_{water}/L_{soil}) = 0.15
n	=	total soil porosity (L_{pore}/L_{soil}) = 1 - (ρ_b/ρ_s) = 0.434
K_d	=	soil-water partition coefficient, cm^3/g

The following equation was used to derive Kd (USEPA, 2002).

$$Kd = K_{OC} \times f_{OC}$$

where:

K_{OC}	=	soil organic carbon partition coefficient (cm^3 / g), chemical specific
f_{OC}	=	fraction organic carbon in soil (g/g), 0.006

Tables B1.3 through B1.12, in Appendix B, illustrate the calculated values for the above described parameters resulting in CA for each COPC, for soil of SMA 5, for surface soil and subsurface soil. Tables B1.13 and B1.14 present the calculated ECs for industrial/commercial workers and construction workers exposed to soil of SMA 5, respectively.

Dermal Absorption

Average daily chemical intake for dermal absorption of chemicals in soil was calculated by use of the following formula (USEPA, 2004):

$$DAD = \frac{DA_{event} \times EF \times ED \times EV \times SA}{BW \times AT}$$

where:

DAD	=	dermal absorbed dose (mg/kg-day)

DA_{event} = absorbed dose per event (mg/cm^2-event)
EF = exposure frequency (days/year)
ED = exposure duration (years)
EV = event frequency (events/day)
SA = skin surface area available for contact (cm^2)
BW = body weight (kg)
AT = averaging time (period over which exposure is averaged, days)

The DA_{event} term was calculated by the following formula (USEPA, 2004):

$$DA_{event} = CS \times CF \times AF \times ABS_d$$

where:

DA_{event} = absorbed dose per event (mg/cm^2-event)
CS = chemical concentration in soil (mg/kg)
CF = conversion factor (10^{-6}kg/mg)
AF = adherence factor of soil to skin (mg/cm^2-event)
ABS_d = dermal absorption fraction

Table B1.15 and B1.16, in Appendix B, present the calculated values for DAevent for surface soil and subsurface soil of SMA 5, respectively. Table B1.17 and B1.18 present the dermal absorbed dose (DAD) for industrial/commercial workers and construction workers exposed to soil, respectively.

3.4 Toxicity Assessment

The toxicity assessment identifies the toxicity values (i.e. slope factors and reference doses) for COPCs. These toxicity values are applied to the estimated doses (intakes) calculated in the exposure assessment, in order to evaluate carcinogenic risk and noncarcinogenic hazard. The Integrated Risk Information System (IRIS) (USEPA, accessed on-line) is the preferred source of toxicity values, as the Tier 1 option. If a toxicity value was not available through IRIS, USEPA's recommended hierarchy of toxicity databases was followed (per USEPA, 2003) which suggests that the Tier 2 option should be the Provisional Peer Reviewed Toxicity Values (PPRTVs) developed by The Office of Research and Development(ORD)/National Center for Environmental Assessment (NCEA).

3.4.1 Carcinogenicity Evaluation

Carcinogenic oral slope factors (SFs) are presented on Table 3-6, containing the following information for each COPC: weight of evidence, and for oral, inhalation, and dermal pathways, tumor site(s), unit risk values, and SFs. References are provided as necessary.

Presently, toxicological data do not exist from which dermal SFs can be derived. To evaluate the dermal pathway, USEPA has adopted methodology to obtain dermal SFs by adjusting the oral SFs. The equation for extrapolation of a default dermal SF is as follows:

$$\text{Default Dermal SF} = \text{Oral SF} \ / \ \text{Oral Absorption Factor (\%)}$$

Dermal SFs are also presented on Table 3-6 and include the oral absorption factor (oral bioavailability) data properly referenced.

Inhalation cancer risks are calculated by use of the Inhalation Unit Risk (IUR) Factors: Table 3-7 provides a list of IURs utilized, along with the appropriate source referenced.

3.4.2 Noncarcinogenic Hazards Evaluation

Oral reference doses (RfDs) are derived from toxicological data and can be obtained from USEPA toxicological databases, such as IRIS. However, for the dermal pathway, oral RfDs are adjusted to derive dermal RfDs in an approach similar as that described above for the derivation of dermal SFs, and as follows:

$$\text{Dermal RfD} = \text{Oral RfD} \times \text{Oral Absorption Factor (\%)}$$

Noncarcinogenic oral RfDs are presented on Table 3-8, and for each COPC include the critical effect/target organ affected and are properly referenced. Table 3-8 also contains dermal RfDs, and includes the oral absorption factors for each COPC along with the proper reference.

Inhalation noncancer risks are calculated by use of the inhalation reference concentrations (RfCs); Table 3-9 provides a list of IURs utilized, along with the appropriate source referenced.

3.5 Risk Characterization

The objective of the risk characterization step is to integrate the information developed in the exposure assessment and the toxicity assessment into an evaluation of the potential current and future health risks associated with the COPCs at the Site. Potential cancer risk was calculated by multiplying the estimated lifetime-averaged daily intake that is calculated for a chemical through an exposure route by the exposure route-specific cancer slope factor, as described below.

$$\text{ELCR} = \text{DI} \times \text{SF}$$

where:

ELCR	=	Excess Lifetime Cancer Risk (unitless)
DI	=	Daily intake of chemical (mg/kg-day)

SF = Cancer slope factor $(mg/kg\text{-}day)^{-1}$

Excess cancer risk for the inhalation pathway was estimated by utilizing the following formula (USEPA, 2009):

$$ELCR_{Inhalation} = IUR \times EC$$

where:

$ELCR_{Inhalation}$ = cancer risk via the inhalation pathway (unitless)
IUR = inhalation unit risk $[(\mu g/m^3)^{-1}]$
EC = exposure concentration $(\mu g/m^3)$

Cancer risks are then summed to calculate total risks to a receptor from all chemicals and from all exposure routes.

The potential for noncarcinogenic health effects was evaluated by the calculation of hazard quotients (HQs) and hazard indices (HIs) (which are HQs summed). An HQ is the ratio of the exposure duration-averaged estimated daily intake through a given exposure route to the chemical and route-specific reference dose, calculated as presented below.

$$HQ = DI / RfD$$

where:

HQ = Hazard quotient (unitless)
DI = Daily chemical intake (mg/kg-day)
RfD = Noncancer reference dose (mg/kg-day)

The HQ for the inhalation pathway was calculated by using the following formula (USEPA, 2009):

$$HQ_{Inhalation} = EC / [\text{ Toxicity Value } \times 1000 \ \mu g/m3]$$

where:

HQ = hazard quotient via the inhalation pathway (unitless)
EC = exposure concentration $(\mu g/m^3)$
Toxicity Value = inhalation toxicity value (e.g. RfC)

HQs are totaled to calculate HIs for each receptor scenario. Initially, HIs are calculated based on all chemicals and exposure routes. Following the calculation of cumulative noncancer risks, any receptors which exhibit an HI greater than 1.0 are further evaluated to determine if multiple organ affects are demonstrated. If so, chemicals are segregated by organ effect and cumulative noncancer risks and re-evaluated separately.

Risk Results for Soil

Industrial/commercial workers were evaluated for their exposure to surface soil (0-1 ft) and construction workers were evaluated for their exposure to surface and subsurface soil (0-9 ft) of SMA 5. The calculated results for each chemical and pathway are presented on Tables B2.1 and B2.2 for industrial/commercial workers and construction workers, respectively. Risk results for these receptors are summarized on Table 3-10.

For industrial/commercial workers, cumulative excess cancer risk from exposure to chemicals in surface soil, summed over all pathways, was found to be 9.7E-06, which falls within EPA's acceptable risk range of 1E-06 to 1E-04. Chemicals that predominantly contribute to this ELCR include: benzo(a)pyrene (2.4E-06), arsenic (3.6E-06) and chromium (2.1E-06). ELCRs from these three chemicals represent 84% of the total cancer risk. Preliminary cleanup standards (PCSs) are calculated for these three chemicals, as explained further below in Section 3.7. Concentrations of benzo(a)pyrene, arsenic and chromium in surface soil are presented on Figure 3-2. The noncancer HI result for industrial workers exposed to surface soil of SMA 5 is 0.02, far below the level of concern of 1.0.

For construction workers, total excess cancer risk from exposure to chemicals in surface and subsurface soil, summed over all pathways, was found to be 7.7E-06. The majority of this ELCR is contributed by benzo(a)pyrene (4.1E-06) and dibenzo(a,h)anthracene (1.0E-06). ELCRs from these two chemicals represent 66% of the total cancer risk. Concentrations of benzo(a)pyrene and dibenzo(a,h)anthracene in surface and subsurface soil are presented on Figure 3-3. PCSs are calculated for these chemicals, as explained further below in Section 3.7. The noncancer HI result for construction workers exposed to subsurface soil of SMA 5 is 0.2, far below the level of concern of 1.0.

Human Health Risk Assessment Conclusions

Cumulative excess lifetime cancer risks (ELCRs) and hazard indices (HIs) were calculated for industrial/commercial workers and construction workers at SMA 5. Industrial/commercial workers were evaluated as being exposed to surface soil, 0-1 ft, and construction workers were evaluated as being exposed to soil from the surface to a depth of 9 ft. The groundwater pathway at SMA 5 is not complete; hence the cumulative risk results for receptors include only the complete pathways of soil ingestion, inhalation, and dermal absorption. Cumulative ELCRs for industrial/commercial workers and construction workers were found to be within the acceptable risk range of 1E-06 to 1E-04, as 9.7E-06 and 7.7E-06, respectively. Hazard indices for industrial/commercial workers and construction workers also were found to be below the level of concern (1.0), as 0.02 and 0.2, respectively. Hence, current and future receptors' exposure to site soil, under the scenarios presented in this risk assessment, do not demonstrate unacceptable levels of risks at SMA 5.

3.6 Uncertainty Analysis

There are a number of factors that contribute uncertainty to the estimates of exposure and risk presented above. Uncertainties based upon derivation and use of toxicological values are inherent in each risk characterization. Some of these include:

- The use of animal data to predict potential human health effects.
- Extrapolation of experimental data obtained by exposing animals to high chemical doses to the likely outcome in humans following exposure to low chemical levels in the environment.
- The use of conservatively derived toxicological criteria.
- The lack of toxicity data for some chemicals evaluated in the risk characterization.
- Lack of toxicity criteria specific for evaluating the dermal route of exposure.

When evaluating exposure, probable scenarios are developed to estimate conditions and duration of human contact with a COPC. Scenarios are based on observations or assumptions about the current or potential activities of human populations that could result in direct exposure. To prevent underestimations of risk, scenarios incorporate exposure levels, frequencies, and durations at or near the top end of the range of probable values. This RME approach is one that may be at the high end of the range of possible exposures.

Default values, such as ingestion rates, are used in the exposure calculations to quantify intakes. Although these values are based on USEPA-validated data, there is uncertainty in the applicability of such values to any particular exposed population or individual. To compensate for this uncertainty, the default values are typically set to the upper end (usually the 90th or 95th percentile) of the normal range.

3.7 Preliminary Cleanup Standards

PCSs were calculated for every chemical resulting in an excess lifetime cancer risk of 1E-06 or greater or a hazard quotient of 1.0 or greater. These chemicals are also known as chemicals of concern (COCs), or risk drivers, as they are the chemicals which would be moved forward to the Corrective Measures Study phase to evaluate alternatives for clean-up to ensure protectiveness. In order to evaluate clean-up strategies, a clean-up level must first be established, hence the need to calculate PCSs for resulting COCs.

The process to calculate PCSs is essentially the risk calculation in reverse (USEPA, 1991). To calculate PCSs, a target risk level is first determined, such as 1E-06, and then the concentration of the COC in soil which would result in that level of risk is determined. The same exposure parameters and pathways are utilized to calculate PCSs as were used to calculate risk. To provide more information for risk management decisions, PCSs are presented for three levels of target risk, 1E-06, 1E-05, and 1E-04, and three levels of noncancer hazard, 0.1, 1.0, and 3.0.

PCS calculations for each soil exposure pathway are presented in Tables B3.1 through B3.3 for industrial workers exposed to surface soil and Tables B3.4 through B3.6 for construction workers exposed to subsurface soil. Table B3.7 presents the noncarcinogenic calculations for both industrial/commercial workers and constructions and Table B3.8 presents the carcinogenic calculations for both receptors. PCSs for all COCs are summarized for both receptors in Table 3-11.

4.0 IDENTIFICATION AND DEVELOPMENT OF REMEDIAL GOAL OBJECTIVES AND GENERAL RESPONSE ACTIONS

This CMS Report presents the results of the step-by-step evaluation of corrective measure alternatives at SMA 5 under the 2012 AOC. This report reflects the typical CMS format, with Sections 4.0 through 8.0 organized to match the four steps of the CMS process.

This section presents Step 1 of the CMS Process – Development of Cleanup Goals, Corrective Action Objectives, and General Response Actions. Corrective Action Objectives (CAOs) are medium-specific goals for protecting human health and the environment. Attainment of these goals, which specify the contaminants of concern (COCs), the exposure route(s), and acceptable contaminant levels for each receptor, will result in residual concentrations that are within acceptable levels of risk to human health and the environment. Therefore, the purpose of Step 1, as summarized in this section, is to establish media cleanup goals such that CAOs can be developed and general response actions can be identified for the protection of site receptors from potentially contaminated media at SMA 5.

4.1 Preliminary Cleanup Standards (PCSs) From Human Health Risk Assessment

Medium-specific, as well as chemical-specific, calculated assumed risk assessments were developed in Section 3.0 as required by the 2012 AOC. For this CMS, acceptable exposure levels for the contaminants of concern calculated in the risk assessment for SMA 5 (Section 3.0) were used to develop media specific cleanup goals. The media cleanup goals provide current and long-term considerations to use during analysis and selection of corrective action alternatives.

The risk assessment results calculated in Section 3.0 were prepared to calculate total risk to the risk level to 1E-06 or HQ of 1.0 as appropriate and applying the assumed exposure factors consistent with the risk assessment as required by the 2012 AOC. For constituents that exceeded an excess lifetime cancer risk (ELCR) of 1E-06 or a HQ of 1, PCSs were calculated. The PCSs were calculated to levels that would achieve ELCR of 10^{-4}, 10^{-5}, and 10^{-6} and HQs of 3, 1, and 0.1.

As discussed in the OSWER Directive 9355.0-30 dated April 22, 1991, acceptable risk levels for cumulative carcinogenic risks to an individual based on exposure assumptions can range from 10^{-4} to 10^{-6} as long as the cumulative excess lifetime carcinogen site risk is less than 10^{-4} and the noncancer hazard quotient (HQ) is less than 1. In order to meet the goal of the cumulative excess lifetime carcinogen site risk being less than 10^{-4} across all media, the analytical samples from each sample media were screened against the calculated PCS at an ELCR of 10^{-5} or a HQ of 1.0. If the risk for a particular constituent did not exceed the ELCR of 10^{-5} or a HQ of 1.0, then the constituent was screened out because it did not exceed the target risk level for corrective action.

If a receptor exceeded the 10^{-5} ELCR or HQ of 1.0 for a constituent, then the media in which it exceeded the ELCR or HQ is considered for corrective action. If multiple receptors exceeded the target risk levels for a specific media, then the most conservative PCS value for the 10^{-5} ELCR or 1.0 HQ was used to screen the data.

The ERP Coke facility including all of SMA 5 is industrial, and future land use will continue to be industrial. Therefore, PCSs were calculated for only the Industrial/Commercial Worker scenario and the construction worker scenario for all completed pathways as appropriate.

4.1.1 Surface Soil PCSs

The Industrial/Commercial Worker exposure to surface soil was determined to be the completed pathway for the surface soil. Surface soil samples were collected in SWMU 44 from borings SB44001 through SB44003 and in SWMU 45 from borings SB45001 and SB45004 during the preparation of this CMS and are shown on Figure 2-1. The surface soil samples were collected from the 0- to 1-foot bgs depth interval in SMA 5. A surface soil sample could not be collected in boring SB45002 and SB45004 due to the presence of gravel. Surface soil samples were not collected from SWMU 43. SWMU 43 lies between two railroad tracks and the upper foot consisted of non-native fill and this area is continually disturbed by grading. These collected surface soil samples were used to calculate the risk to the Industrial/Commercial Worker. A summary of the analytical data for the surface soil collected in SMA 5 is included in Table 1 in Appendix A. The surface soil risk summary based on the exposure assumptions for Industrial/Commercial Workers is included as Table 4-1. For industrial/commercial workers, cumulative excess cancer risk from exposure to chemicals in surface soil, summed over all pathways, was found to be 9.7E-06, which falls within EPA's acceptable risk range of 1E-06 to 1E-04. Chemicals that predominantly contribute to this ELCR include: benzo(a)pyrene, arsenic, and chromium. ELCRs from these three chemicals represent 84% of the total cancer risk. Concentrations of select COCs in surface soil (0-1 ft) are presented on Figure 3-2. The noncancer HI result for industrial workers exposed to surface soil of SMA 5 is 0.02, far below the level of concern of 1.0.

Table 4-1
Risks Summary – Industrial/Commercial Workers, Assumed Exposure to Surface Soil
Major Contributors to Total Risk† - Summed Over All Exposure Pathways

Chemical	ELCR	HQ
Benz(a)anthracene	2.6E-07	NA
Benzo(a)pyrene	**2.4E-06**	NA
Benzo(b)fluoranthene	4.1E-07	NA
Benzo(k)fluoranthene	1.3E-08	NA
Chrysene	3.6E-09	NA
Dibenz(a,h)anthracene	7.0E-07	NA
Indeno(1,2,3-cd)pyrene	1.7E-07	NA
Arsenic	**3.6E-06**	1.8E-02

Chemical	ELCR	HQ
Chromium	**2.1E-06**	3.8E-03

ELCR = Excess Lifetime Cancer Risk

HQ = Hazard Quotient

†**BOLD** font depicts chemicals exhibiting ELCRs greater than 1E-06 and HQs greater than 1.0.

NA = not applicable; toxicity factors are not available for these chemicals

For industrial/commercial workers, cumulative excess cancer risk from exposure to chemicals in surface soil, summed over all pathways, was found to be 9.7E-06, which falls within EPA's acceptable risk range of 1E-06 to 1E-04, and the HI is less than 1.0. Therefore, remediation of surface soils is not required, and PCSs are not presented.

4.1.2 Soil PCSs

The Construction Worker exposure to surface and subsurface soil (0- to 9-feet) was the completed pathway for the surface and subsurface soil. Soil samples were collected in SWMU 43 from borings SB43001 through SB430003, in SWMU 44 from borings SB44001 through SB44003 and in SWMU 45 from borings SB45001 and SB45004 during the preparation of this CMS and are shown on Figure 2-1. The surface soil samples were collected from the 0- to 1-foot bgs depth interval in SMA 5, and subsurface soil samples were collected from the 1- to 9-feet depth interval in SMA 5. The surface soil and subsurface soil samples were used to calculate the risk to the Construction Worker. A summary of the analytical data for the soil collected in SMA 5 is included in Tables 1 and 2 in Appendix A. The soil risk summary based on the exposure assumptions for Construction Workers is included as Table 4-2. For construction workers, total excess cancer risk from exposure to chemicals in surface and subsurface soil, summed over all pathways, was found to be 7.7E-06. The majority of this ELCR is contributed by benzo(a)pyrene and dibenzo(a,h)anthracene. ELCRs from these two chemicals represent 66% of the total cancer risk. Concentrations of select COCs in the subsurface are presented on Figure 3-3. The noncancer HI result for construction workers exposed to subsurface soil of SMA 5 is 0.2, far below the level of concern of 1.0.

Table 4-2
Risks Summary - Construction Workers, Assumed Exposure to Subsurface Soil
Major Contributors to Total Risk† - Summed Over All Exposure Pathways

Chemical	ELCR	HQ
Benz(a)anthracene	1.7E-07	NA
Benzo(a)pyrene	**4.1E-06**	NA
Benzo(b)fluoranthene	3.6E-07	NA
Benzo(k)fluoranthene	1.2E-08	NA
Chrysene	2.2E-09	NA
Dibenz(a,h)anthracene	1.0E-06	NA
Indeno(1,2,3-cd)pyrene	3.3E-07	NA
Naphthalene	6.6E-08	5.5E-02

Chemical	ELCR	HQ
Arsenic	8.7E-07	1.3E-01
Chromium	8.3E-07	3.9E-02
Mercury	--	3.4E-07

ELCR = Excess Lifetime Cancer Risk
HQ = Hazard Quotient
†**BOLD** font depicts chemicals exhibiting ELCRs greater than 1E-06 and HQs greater than 1.0.
NA = not applicable; toxicity factors are not available for these chemicals

For construction workers, total excess cancer risk from exposure to chemicals in surface and subsurface soil, summed over all pathways, was found to be 7.7E-06., which falls within EPA's acceptable risk range of 1E-06 to 1E-04, and the HI is less than 1.0. Therefore, remediation of surface and subsurface soils is not required, and PCSs are not presented.

4.1.3 Summary of PCSs

Since the cumulative ELCR was less than 10-4 and the cumulative HI was less than 1.0 for the industrial/commercial scenario, remediation is not needed in SMA 5 and calculation of PCSs are not required.

4.2 Estimated Areas and Volumes of Affected Media

4.2.1 Surface Soil

Based on the results of the HHRA, no surface soils are targeted or proposed for active remediation. However, land use controls will be recommended that will manage exposure to surface soil in a commercial/industrial setting. The inclusion of land use controls is required to be protective of human health in the future since the trigger for remediation used in this CMS is based on a current and future industrial scenario. Since the risk assessment and cleanup decision is assuming a future land use scenario of "industrial" (i.e., cleanup to residential standards is not being pursued), ERP Coke is proposing the installation of land use controls needed to ensure that land use does not become residential.

4.2.2 Subsurface Soil

Based on the results of the HHRA, no subsurface soils are targeted or proposed for active remediation. However, land use controls will be recommended that will manage exposure to subsurface soil in a commercial/industrial setting. The inclusion of land use controls is required to be protective of human health in the future since the trigger for remediation used in this CMS is based on a current and future industrial scenario. Since the risk assessment and cleanup decision is assuming a future land use scenario of "industrial" (i.e., cleanup to residential standards is not being pursued), ERP Coke is proposing the installation of land use controls needed to ensure that land use does not become residential.

4.3 Corrective Action Objectives

The corrective action objectives (CAOs) are medium-specific goals and specify the COCs, the exposure route(s) and receptor(s), and an acceptable contaminant level (i.e., remediation goal). The overall CAOs for SMA 5 are:

- Protect human health and the environment.
- Achieve the chemical-specific PCSs for each media, including restoration of groundwater to drinking water standadrs, or any other standards established by statute
    - Selection of cleanup standards also requires the establishment of points of compliance which represents where the media clean up levels are to be achieved; remediation time frame which is the site-specific schedule for a remedy) including both time frame to construct the remedy and estimate of the time frame to achieve the cleanup levels at the point of compliance).
- Control the source(s) of release so as to reduce or eliminate, to the extent practicable, further releases of hazardous waste or hazardous constituents that may pose a threat to human health and the environment.
- Comply with any applicable waste management standards.

The following three sections for the various receptors indicate the chemical-specific PCSs associated with each media to meet the CAOs.

4.3.1 Commercial/Industrial Worker

No surface or subsurface soil contaminant concentrations exceeded the PCSs for a Commercial/Industrial setting for a Commercial/Industrial Worker; therefore, the CAOs are met for a worker in a Commercial/Industrial setting.

4.3.2 Construction Worker

No surface or subsurface soil exceeded the PCSs for a Construction setting for a Construction Worker; therefore, the CAOs are met for a Construction Worker in a Commercial/Industrial setting.

4.4 General Response Actions

General response actions describe those actions that will satisfy the CAOs for all media. General response actions were considered for evaluation based on their adequacy to address affected media exceeding the PCSs. The response actions identified for this CMS are listed below and described in the subsequent sections.

- No Action
- Institutional Controls

4.4.1 No Action

The No Action response establishes a baseline for alternative comparison. A no action alternative can include limited environmental monitoring to assess the impacts associated with no remedial actions, but cannot include actions to minimize risk by reducing either contaminant exposure pathways or contamination through treatment. The No Action response action proposed for this site would not include any environmental monitoring, remedial activity, or land use restrictions.

4.4.2 Institutional Controls

Institutional controls consist of land use controls including any type of physical, legal, or administrative mechanism that restricts use of or limits access to real property to prevent or reduce risks to human health and the environment. Physical mechanisms encompass a variety of remedies to contain or reduce contamination and may include physical barriers intended to limit access to property, such as fences or signs. Legal mechanisms include restrictive covenants, equitable servitudes, and deed notices. Administrative mechanisms include notices and construction permitting or land use management systems that may be used to ensure compliance with use restrictions. The legal mechanisms used for land use controls are generally imposed to ensure that restrictions on land use developed as part of an action remain in place.

5.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

This section describes the identification and screening of potentially applicable corrective action technologies and process options for each general response action described in Section 4.0 that may be applied to reduce and/or eliminate exposure to affected media at SMA 5. Screening potential technologies is an optional step and not required in the CMS process according to the Corrective Measures Study Scope of Work located at the website http://www.epa.gov/reg3wcmd/pdf/chev6.pdf referenced in Paragraph 29 of the AOC.

The identification of technologies for this CMS has been focused on realistic remedies that will achieve the corrective action objectives (see Section 4.3) for soil at the site. USEPA presumptive remedies http://www.epa.gov/oerrpage/superfund/policy/remedy/presump/ pol.htm was reviewed and used to streamline the identification process. Process options that represented the full spectrum of options for each technology were then identified so that a technology would not be eliminated during the screening process because of an overly narrow choice of process options.

The selection of corrective action technologies and process options to be considered for screening was based solely on technological limitations with respect to the unsuitability for the COCs identified in the media at SMA 5, the magnitude of COC concentrations, the characteristics of the materials, the distribution and location of the waste materials, and site-specific conditions such as topography and hydrogeologic characteristics (USEPA, 1994). The selected technologies and process options were then evaluated in terms of effectiveness, implementability, and cost (with particular emphasis on effectiveness) using a *High*, *Medium*, and *Low* benefit rating system. A description of the screening criteria is presented below:

- Effectiveness. The effectiveness of a given process option was determined based on its ability to remediate the estimated volume of contaminated media and meet the cleanup levels listed in the CAOs. A *High* ranking indicates that the technology would be very effective.

- Implementability. The ease or difficulty to implement the process option was evaluated in terms of the technical and administrative issues. A *High* ranking indicates that the technology would be easy to implement.

- Cost. A qualitative cost estimate of the process options was evaluated relative to the other process options under evaluation. The costs considered include capital costs and operation and maintenance costs. A *High* ranking indicates that the technology would be relatively inexpensive to implement when compared to the other technologies.

A description of each potentially applicable technology type and associated process options relative to soils, sediment, and groundwater are presented in the following subsections.

5.1 Surface and Subsurface Soil

5.1.1 No Action

The No Action response assumes that no additional source control measures will be implemented and no monitoring will be performed. As a result, no technologies or process options have been identified for the No Action response. No Action has been retained for further consideration as a corrective measures technology to serve as a basis of comparison.

5.1.2 Land Use Controls

The corrective measures technology identified for the Institutional Controls response is Land Use Controls. Land Use Controls consists of physical, legal, and administrative mechanisms to restrict the use of or limit access to affected areas of the site to protect current and future receptors.

Given that the proposed remedies for each of the SMAs relies on a LUCIP to be protective, it is anticipated that EPA's final remedy proposal will require an Environmental Covenant pursuant to the Alabama Uniform Environmental Covenants Act, Code of Alabama 1975, §§35-19-1 to 35-19-14. Such covenants are necessary if the final remedy places a land use control at a facility because it is not being remediated to unrestricted use.

5.1.3 Other Process Options

Since none of the soil concentrations exceeded the PCS for the commercial/Industrial use, no other remedial options are being considered for the soil in SMA 5.

5.1.4 Summary Screening Technologies Retained for Soil Remediation

The following technologies were retained for further consideration for groundwater remediation:

- No Action
- Physical Barriers
- Legal Barriers
- Administrative Barriers

6.0 DEVELOPMENT OF CORRECTIVE ACTION ALTERNATIVES

Potential remedies for addressing contamination in site media are developed by assembling combinations of corrective measure technologies screened in Section 5.0 in order to meet the CAOs. Once Corrective Action Alternatives are developed, the alternatives will be compared against one another in Section 7.0. The Corrective Action Alternative chosen for the site will be recommended and justified in Section 8.0.

6.1 Corrective Measure Technology Screening

The corrective measure technologies (CMT) remaining from the screening process (Section 5.0) have been combined in this section to develop corrective action alternatives (CAA) for surface soil and subsurface soils that meet the CAOs for SMA 5. The CMT and process options to be evaluated are listed in the table below:

Table 6-1
List of Corrective Measure Technologies and Process Options

No.	General Response Action	Corrective Measure Technology	Process Options
CMT1	No Action	None	None
CMT2	Institutional Actions	Land Use Controls	Physical Barriers (Fence/Signs)
CMT3	Institutional Actions	Land Use Controls	Legal Barriers
CMT4	Institutional Actions	Land Use Controls	Administrative Barriers

CMT=Corrective Measure Technology

The CMTs listed in the above table were evaluated individually for each media and each exposure pathway in terms of satisfying the components of the CAOs developed for the site. If the implementation of a given CMT would result in the partial attainment of the CAOs for that media in tables 6-2 and 6-3, then it was assigned a yes and selected as a corrective measure technology. When all of the individual media and exposure pathways had been assessed individually, then the individual CMTs were combined to form CAAs that are presented in Table 6-4.

Table 6-2
Evaluation and Screening of Potential
Corrective Measure Technologies for Surface Soil

No.	General Response Action	Corrective Action Technology (Process Option)	Surface Soil	
			Satisfy CAO for Construction Worker?	Satisfy CAO for Industrial Worker?
CMT1	No Action	None	NO	NO
CMT2	Institutional Actions	Physical Barriers (Fence/Signs)	**YES**	**YES**
CMT3	Institutional Actions	Legal Barriers	**YES**	**YES**
CMT4	Institutional Actions	Administrative Barriers	**YES**	**YES**

CMT=Corrective Measure Technology

Based on the results of the evaluation as summarized in Table 6-2, the following CMTs met the requirements of the set of CAOs for surface soil in SMA 5 and were selected to be combined with other media remedial options to form corrective action alternatives:

CMT1: No Action (to serve as a baseline)
CMT2 + CMT3 + CMT4: Land Use Controls (Administrative and Physical)

Table 6-3
Evaluation and Screening of Potential
Corrective Measure Technologies for Subsurface Soil

No.	General Response Action	Corrective Action Technology (Process Option)	Subsurface Soil	
			Satisfy CAO for Construction Worker?	Satisfy CAO for Industrial Worker?
CMT1	No Action	None	NO	NO
CMT2	Institutional Actions	Physical Barriers (Fence/Signs)	**YES**	**YES**
CMT3	Institutional Actions	Legal Barriers	**YES**	**YES**
CMT4	Institutional Actions	Administrative Barriers	**YES**	**YES**

CMT=Corrective Measure Technology

Based on the results of the evaluation as summarized in Table 5-3, the following CMTs met the requirements of the set of CAOs for subsurface soil in SMA 5 and were selected to be combined with other media remedial options to form CAAs:

CMT1:	No Action (to serve as a baseline)
CMT2 + CMT3 + CMT4:	Land Use Controls (Administrative and Physical)

6.2 Corrective Action Alternatives

The corrective action alternatives selected for SMA 5 were intended to represent a broad spectrum of remedial options, ranging from alternatives such as land use controls that prevent or control exposure to active alternatives that employ treatment to reduce toxicity, mobility, or volume.

A total of two corrective action alternatives have been developed by combining the corrective measure technologies screened in Section 6.1 to satisfy the CAOs for the contaminated media present in SMA 5. Parameters specific to SMA 5, including the variation of site activities and areas of exposure associated with the industrial worker and construction worker scenarios, allowed for adequate differentiation among the two alternatives with respect to effectiveness, implementability, and cost. The corrective action alternatives (CAA) for the site are listed below:

- CAA 1 No Action
- CAA 2 Physical , Legal , and Administrative Barriers (Land Use Controls)

Additional components of these alternatives with respect to the impacted media at the site are listed in the table below:

Table 6-4
Components of the Multi-Media Corrective Action Alternatives

	Corrective Action Alternatives	
Components	1	2
Surface Soil/Subsurface Soil *No Action*	¨	
Land Use Controls		¨

A detailed description of each alternative is provided in the subsections below.

6.2.1 CAA 1—No Action

The No Action corrective action alternative assumes that no further remedial action will occur at SMA 5 and has been included to establish a baseline for alternative comparison. Alternative 1 can include limited environmental monitoring to assess the impacts associated with no remedial response action, but cannot include actions to minimize risk by reducing either contaminant exposure pathway or contamination through treatment. Alternative 1 for SMA 5 would not meet the CAOs.

6.2.2 CAA 2— Physical , Legal , and Administrative Barriers (Land Use Controls)

The Physical Barrier, Legal Barrier, and Administrative Barrier (Institutional Control) alternatives consist of administrative and physical mechanisms to place restrictions on the use of and limit access to the site and/or SWMUs/AOCs to prevent exposure to site contaminants. SMA 5 is completely fenced, and the facility is manned twenty-four hours a day 365 days a year.

Applying land use controls at SMA 5 to maintain the site as Industrial will:

- ensure protection against the site becoming a future unrestricted residential land use scenario (i.e., to keep the land use industrial).
- be consistent with land use controls necessary to deal with contamination above cleanup standards at the other 4 SMAs at the facility.
- be protective of higher levels of contamination, if any, that may not have been detected by sampling within SMA 5.
- be conservative and protective down to one order of magnitude below the recommended cancer risk level.

A land use control implementation plan (LUCIP) would be prepared according to USEPA guidance developed in 2012 (http://www.epa.gov/superfund/policy/ic/guide/index.htm). The LUCIP would identify the objective of the controls to restrict activities within the SMA 5 boundary, list the actions necessary to achieve the objective, and warn potential human receptors of the contaminants at the site. The LUCIP is intended to protect current and future receptors and consists of physical, legal, and administrative land use controls. The LUCIP would include the following information:

- A description of the land along with the certified land survey location of the boundary with respect to state plane coordinates,
- Placing a deed restriction on the property to limit the site to Industrial/Commercial Land Use.
- Placing a deed restriction on the property to limit the use of groundwater.
- An explanation of the land use control including permits to perform any digging activities and the proper personal protective equipment (PPE) that must be used to protect workers, and the use of a fence and signs as necessary to prevent unauthorized access,
- Identification of the facility program point-of-contact designated responsible for implementing the LUCIP,
- An on-site compliance monitoring program,

- Notification procedures to USEPA and ADEM whenever the facility anticipates a major change in land use,
- An annual field inspection and report submitted to USEPA and ADEM to document the effectiveness of the land use controls,
- A certification of the annual report by the designated official to continue compliance with the LUCIP,
- A procedure to notify USEPA and ADEM immediately upon discovery of any unauthorized major change in land use or any activity inconsistent with the LUCIP and the actions that would be implemented to ensure protectiveness, and
- A procedure to provide advance notification to EPA and ADEM of impending transfer, by sale or lease, of SMA 5.

7.0 EVALUATION OF THE CORRECTIVE ACTION ALTERNATIVES

The purpose of the detailed analysis is to provide risk managers with a baseline for evaluating alternatives and selecting the appropriate site remedy. A typical detailed analysis consists of the following components:

- An assessment and summary profile of each alternative individually against the evaluation criteria.
- A comparative analysis among the alternatives to assess the relative performance of each alternative with respect to each evaluation criterion.

This section presents a detailed analysis of the corrective measure alternatives proposed for SMA 5 and summarizes the degree to which each alternative will comply with the requirements of the evaluation criteria.

7.1 Evaluation Criteria

To assist in the evaluation of two corrective action alternatives (CAA) developed for this site, the nine evaluation criteria presented in the Advanced Notice of Proposed Rulemaking (ANPR), *Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities* (USEPA 1996) were used to assess, weigh, and rank the proposed alternatives. As described in the USEPA guidance, the criteria are separated into two groups - threshold criteria and balancing criteria, as summarized below:

- **Threshold Criteria**
  - Protect Human Health and the Environment
  - Attain Media Cleanup Standards
  - Control the Source of Release(s)
  - Comply with Applicable Standards for Waste Management
- **Balancing Criteria**
  - Long-Term Reliability and Effectiveness
  - Reduction of Toxicity, Mobility or Volume of Wastes
  - Short-Term Effectiveness
  - Implementability
  - Cost
  - Community Acceptance
  - State Acceptance

7.1.1 Threshold Criteria

The four threshold criteria are described below:

- ***Protect Human Health and the Environment:*** Alternatives are evaluated to determine if implementation will provide and maintain adequate protection of human health and the environment by eliminating, reducing, or controlling site exposures to acceptable risk levels established in the corrective action objectives.

- ***Attain Media Cleanup Standards:*** Alternatives are evaluated to determine if their implementation would result in the attainment of media cleanup standards derived from existing state or federal regulations, as well as site-specific PCSs. In addition, the time frame necessary for the alternative to meet the standards is included.

- ***Control the Source of Releases:*** Alternatives are evaluated to determine if their implementation would control or eliminate current and future releases (to the extent possible) that may pose a threat to human health and the environment.

- ***Comply with Applicable Standards for Waste Management:*** Alternatives are evaluated to determine if waste management activities associated with the implementation of each alternative would be conducted in compliance with all applicable state or federal regulations.

7.1.2 Balancing Criteria

The Seven balancing criteria are described below:

- ***Long-Term Reliability and Effectiveness:*** Alternatives are evaluated with respect to their demonstrated and expected reliability and permanence based on the degree of certainty that the alternative would prove to be successful in establishing controls to eliminate or manage the risk posed by treatment residuals and/or untreated wastes. Each alternative is also evaluated in terms of its projected useful life (i.e., the length of time the level of effectiveness can be maintained).

- ***Reduction of Toxicity, Mobility, or Volume of Wastes:*** Alternatives are evaluated to determine the degree to which their implementation would reduce or eliminate the toxicity, mobility, or volume of waste at the site. This evaluation focuses on specific factors, including the amount of hazardous materials that will be destroyed or treated, the expected reduction of the toxicity, mobility, and volume, the degree to which the treatment will be irreversible, and the type and quantity of treatment residuals.

- ***Short-Term Effectiveness:*** Alternatives are evaluated with respect to the short-term risks that might be posed to the community, workers, and the environment during the construction and implementation of the alternative. Each alternative is also evaluated in terms of the time that site conditions are protective of human health and the environment.

- ***Implementability:*** Alternatives are evaluated in terms of the ease or difficulty of their implementation considering the technical and administrative feasibility. Technical feasibility includes difficulties and unknowns associated with constructability, time for implementation, time for beneficial results, and availability of technologies, as well as the availability of adequate off-site treatment, storage capacity, disposal services, and technical services and materials. Administrative feasibility includes permits, rights of way, and off-site approvals and the length of time necessary to obtain any approvals.

- ***Cost:*** Alternatives are evaluated in terms of the net present value of capital costs and the present worth of the annual operation and maintenance costs. Capital costs consist of direct costs and indirect costs. Direct costs include labor, equipment, and materials expenditures necessary to install the corrective measure. Indirect costs include engineering, financial, and other service fees apart from installation activities. Cost analyses for the corrective action alternatives are derived from a number of sources, including vendor estimates, estimates from similar projects, actual experience at other sites, and standard costing guidance references. With respect to CERCLA, remedial action alternatives requiring perpetual care are limited to thirty years (USEPA, 2000). This same limitation will be used for costing the corrective action alternatives presented in this document.

- ***Community Acceptance:*** The final CMS will be placed on public notice. The public will then be able to comment on the proposed remedies. This balancing criteria will not be addressed further in this document since EPA will take this criteria into account during the public notice process for the Statement of Basis.

- ***State Acceptance:*** EPA will evaluate the remedies based on the degree to which they are acceptable to the State of Alabama in which the subject facility is located. This is particularly important where EPA, not the State, selects the remedy. This balancing criteria will not be addressed further in this document since EPA will take this criteria into account during the public notice process for the Statement of Basis.

7.2 Threshold Criteria Analysis of the CAAs

This section consists of the evaluation of the relative performance of each of the two alternatives selected for SMA 5 individually in terms of the four threshold criteria described above. Several questions are asked for each of the four threshold criteria. The threshold criteria must be met for each remedy under consideration in order for it to move forward for additional consideration. The threshold criteria are scored either yes, no, or not applicable (NA). The NA response would also be a positive answer for the threshold criteria.

7.2.1 Threshold Criteria for CAA 1 — No Action

Under CAA 1, no action would be taken to mitigate or remediate conditions at the site or control exposure of receptors to the contaminated media. Therefore, the site would remain as it currently exists. The detailed analysis of CAA 1 with respect to the four threshold criteria is described in detail below and summarized in Table 7-1.

<u>CAA 1 - Protect Human Health and the Environment:</u> The environment is protected since there are no ecological receptors in SMA 5. However, the No Action alternative would not achieve the USEPA *de minimis* risk range of 1E-04 to 1E-06 for residential use. Specifically, the risks assessed for this SMA were for industrial and construction scenarios, and the recommended cleanup standards were such that no detected areas of contamination required active remediation

under the industrial and commercial scenarios. However, contamination at levels exceeding residential risk screening levels has been detected. Although residential use is unanticipated, no institutional controls would be taken under Alternative 1 to ensure that the land use remains industrial. Therefore, the implementation of this alternative would not meet the requirements of this threshold criterion.

<u>CAA 1 - Attain Media Cleanup Standards:</u> The risks assessed for this SMA were for industrial and construction scenarios, and the recommended cleanup standards were such that no detected areas of contamination required active remediation under the industrial and commercial scenarios. However, contamination at levels exceeding residential risk screening levels has been detected. Although residential use is unanticipated, no institutional controls would be taken under Alternative 1 to ensure that the land use remains industrial. Therefore, the implementation of this alternative would not meet the requirements of this threshold criterion.

<u>CAA 1 - Control the Source of Releases:</u> Because there are affected media exceeding residential screening levels that have not been capped, removed, or contained, the implementation of this alternative would not meet the requirements of this threshold criterion.

<u>CAA 1 - Comply with Applicable Standards for Waste Management:</u> Since no actions would be performed under this alternative, no wastes would be generated. The requirements of this threshold criteria would be met.

Table 7-1. Summary of Threshold Criteria
CAA 1 – No Action

Evaluation Criteria	Specific Criteria Factor Considerations	SCORE	
Protect Human Health and the Environment	Would exposure be controlled, reduced, or eliminated?	No	No
Attain Media Cleanup Standards	Will cleanup goals for surface exposure be met?	No	
	Will cleanup goals for subsurface exposure be met?	No	
			No
Control Source of Releases	Are further releases reduced or eliminated?	No	
	Is the time frame for attaining the media cleanup standards short?	No	
			No
Comply With Standards for Waste Management	Will waste handling activities be performed in accordance with state and federal regulations?	Yes	
			Yes

7.2.2 Threshold Criteria for CAA 2 — Physical, Legal, and Administrative Barriers (Land Use Controls)

This alternative involves the restriction of access and activities at the site through the installation of fencing, signage and the development of a land use control implementation plan (LUCIP). The detailed analysis of CAA 2 with respect to the four threshold criteria is described in detail below and summarized in Table 7-2.

CAA 2 - Protect Human Health and the Environment: CAA 2 provides fencing, signage, and/or land use controls to reduce the exposure of potential receptors in SMA 5. The area of SMA 5 is currently inside the fenced and secured area of the facility. Since there are no levels of contamination in excess of the cumulative industrial/commercial ELCR of 10-4 or HI of 1.0, remediation is not warranted and land use controls ensures that the facility remains industrial (with a maintained fence). In addition, the environment is protected since there are no ecological receptors in SMA 5. Therefore, this threshold criterion is met.

CAA 2 - Attain Media Cleanup Standards: The media cleanup standard is met because the cumulative industrial/commercial ELCR of 10-4 and HI of 1.0 is met. These are the only applicable standards because Alternative 2 will ensure that the land use remains industrial.

CAA 2 - Control the Source of Releases: There are no affected soils above the cumulative industrial/commercial ELCR of 10-4 or HI of 1.0, and no significant mass of contaminants have been found to exist. In addition, groundwater sampling around SMA 5 did not indicate any groundwater contamination emanating from SMA 5. Therefore, this threshold criterion is met.

CAA 2 - Comply with Applicable Standards for Waste Management: This alternative will not generate wastes. This threshold criterion is met.

Table 7-2. Summary of Threshold Criteria
CAA 2 – Physical, Legal, and Administrative Barriers (Land Use Controls)

EVALUATION CRITERIA	SPECIFIC CRITERIA FACTOR CONSIDERATIONS	SCORE	
Protect Human Health and the Environment	Would exposure be controlled, reduced, or eliminated?	Yes	**Yes**
Attain Media Cleanup Standards	Will cleanup goals for surface exposure be met?	Yes	
	Will cleanup goals for subsurface exposure be met?	Yes	
			Yes
Control Source of Releases	Are further releases reduced?	Yes	
	Are further releases eliminated?	Yes	
			Yes
Comply With Standards for Waste Management	Will waste handling activities be performed in accordance with state and federal regulations?	Yes	
			Yes

7.3 Balancing Criteria Analysis of the CAAs

This comparative analysis identifies the advantages and disadvantages of each alternative which met the four threshold criteria relative to one another using the balancing criteria to enable the risk managers to identify key tradeoffs. The relative performance of each alternative has been evaluated in relation to each of five balancing criteria: long-term reliability and effectiveness; reduction of toxicity, mobility, or volume of waste; short-term effectiveness; implementability; and cost. The balancing criteria are then scored on a scale of 0 to 5 with high being the highest score. If a particular criteria has more than one question, the average of the ratings are calculated to establish the criteria rating. A maximum balancing criteria score of 25 is possible for each CAA. Since this is only relative based on five of the balancing criteria, the chosen CAA may not receive the highest score. A particular balancing criteria may have an overriding effect on the CAA chosen.

CAA 2- Physical, Legal, and Administrative Barriers (Land Use Controls) is the only CAA to satisfy each of the four threshold criteria of the CAA evaluated; therefore, CAA 2 is the only CAA evaluated with respect to the five balancing criteria.

7.3.1 Balancing Criteria for CAA 2 — Physical, Legal, and Administrative Barriers (Land Use Controls)

<u>CAA 2 - Long–Term Reliability and Effectiveness:</u> The LUCIP would be prepared and implemented according to USEPA requirements and would provide long-term reliability and effectiveness through controls to reduce or eliminate exposure by current and future receptors. The fence would also provide additional long-term protection by restricting access to the site. Annual inspections and occasional repairs would be required. The estimated useful life of the LUCIP under this alternative is greater than 30 years. CAA 2 is capable of providing long term reliability and effectiveness.

<u>CAA 2 - Reduction of Toxicity, Mobility, or Volume of Wastes:</u> CAA 2 does not provide treatment options to reduce toxicity or volume; however, the cumulative industrial/commercial risk from the COCs were below the cumulative ELCR of 10-4 and HI of 1.0; therefore, active remediation is not required. Therefore, reducing the toxicity, mobility, or volume does not apply.

<u>CAA 2 - Short-Term Effectiveness:</u> Implementation of CAA 2 will provide protection from the short-term risks to the community and the environment. The known soil contamination does not rise to the level requiring action to remove or protect receptors (i.e., no affected soils above the cumulative industrial/commercial ELCR of 10-4 or HI of 1.0). CAA 2 is capable of providing short-term effectiveness.

CAA 2 – Implementability: CAA 2 would result in no implementation issues. Only an LUCIP would be required to be prepared and implemented. The preparation of a LUCIP would require two to four months. The actions needed to implement CAA 2 are acceptable, can be accomplished and should not prove difficult.

CAA 2 - Cost: The capital costs for implementing this alternative include the labor to prepare a LUCIP would be approximately $35,000. The operation and maintenance costs for this alternative consist of annual visual inspections and the preparation of an annual certification report, and routine repairs of the perimeter fence. The operation and maintenance costs would be approximately $2,000 for each year. The 30-year present worth for this alternative is estimated at $95,000.

Table 7-3. Detailed Analysis of Alternatives – Evaluation Summary and Scoring
CAA 2 – Physical, Legal, and Administrative Barriers (Land Use Controls)

EVALUATION CRITERIA	SPECIFIC CRITERIA FACTOR CONSIDERATIONS	SCORE	
Long-Term Reliability and Effectiveness	How capable is the alternative in providing mitigation or reduction of the severity of the source(s) of potential risk?	0	
	How capable is the alternative in providing long-term protection for receptors through containment systems?	5	
	How capable is the alternative in providing long-term protection for receptors through institutional controls?	5	
			3.3
Reduction of Toxicity, Mobility, or Volume of Waste	How much does the alternative reduce the toxicity of the waste?	0	
	How much does the alternative reduce the mobility of the waste?	0	
	How much does the alternative reduce the volume of the waste?	0	
			0.0
Short-Term Effectiveness	How capable is the alternative at providing short-term effectiveness to address the risk to the community?	5	
	How capable is the alternative at providing short-term effectiveness to address the risk to the workers?	5	
	How capable is the alternative at providing short-term effectiveness to address the risk to the ecological receptors?	5	
			5.0
Implementability	What is the level of difficulty to find adequate TSD services, supplies, and/or equipment?	5	
	What is the level of difficulty to implement, operate, and maintain the chosen technology?	5	
	What is the level of difficulty to implement and maintain the chosen administrative components?	5	
	What is the level of difficulty to implement the alternative in a short time?	5	
			5.0

EVALUATION CRITERIA	SPECIFIC CRITERIA FACTOR CONSIDERATIONS	SCORE	
Cost	Are costs less than $100,000?	5	
	Are costs less than $250,000?	5	
	Are costs less than $500,000?	5	
	Are costs less than $1,000,000?	5	
	Are costs less than $2,000,000?	5	**5.0**
		Total	**18.3**

8.0 JUSTIFICATION AND RECOMMENDATION OF THE CORRECTIVE MEASURES

8.1 Remedy Selection

Based on the activities conducted in this CMS, we have determined:

- The only know contaminated media in SMA 5 is soil.
- The noncancer remediation threshold for soil was not breached.
- The cancer remediation screening level (10-6) soil was breached for an industrial setting for several COCs; however, the cumulative risk of the COCs were below the 1E-04 remediation trigger.
- The cancer and noncancer remediation thresholds for soil were not breached for a construction setting.
- Leachability from soil to groundwater was determined not to be a threat based on COC soil concentrations and groundwater monitoring conducted around SMA 5.
- The soil contamination is not deemed to be a principal threat in need of active remediation.

Based on the conclusions of the detailed analysis that was performed individually and collectively with respect to the six alternatives, Alternative 2 - Land Use Controls is recommended as the corrective action alternative for SMA 5.

As presented in Section 5.2, the land use controls will include the preparation of a land use control implementation plan (LUCIP) according to USEPA Region 4 guidance. The purpose of the LUCIP is to ensure that land use remains industrial, a setting that has been found to be protective for the detected soil concentrations.

The LUCIP will also add a layer of protection beyond that needed to address the level of soil contamination identified in the SMA 5 risk assessment. The LUCIP will also be:

- consistent with land use controls necessary to deal with contamination above cleanup standards at the other 4 SMAs.
- protective of higher levels of contamination, if any, that may not have been detected by sampling within SMA 5.
- conservative and protective down to one magnitude below the recommended cancer risk level.

The LUCIP would identify the objective of the controls to restrict activities within the SMA 5 boundary, list the actions necessary to achieve the objective, and provide notice to onsite individuals of the contaminants at the site. It is recommended that the LUCIP included, at a minimum, the following controls:

- A description of the land along with the certified land survey location of the boundary with respect to state plane coordinates,
- Placing a deed restriction on the property to limit the site to Industrial/Commercial Land Use.
- An explanation of the land use control including permits to perform any digging activities and the proper personal protective equipment (PPE) that must be used to protect workers, and the use of a fence and signs as necessary to prevent unauthorized access,
- Identification of the facility program point-of-contact designated responsible for implementing the LUCIP,
- An on-site compliance monitoring program,
- Notification procedures to USEPA and ADEM whenever the facility anticipates a major change in land use,
- An annual field inspection and report submitted to USEPA and ADEM to document the effectiveness of the land use controls,
- A certification of the annual report by the designated official to continue compliance with the LUCIP,
- A procedure to notify USEPA and ADEM immediately upon discovery of any unauthorized major change in land use or any activity inconsistent with the LUCIP and the actions that would be implemented to ensure protectiveness, and
- A procedure to provide advance notification to EPA and ADEM of impending transfer, by sale or lease, of SMA 5.

This alternative will be the most efficient and economical method to meet the CAOs for SMA 5 and provide long-term protection of human health and the environment.

8.2 Post-Remedy Selection

After EPA issues its Response to Comments (RTC) and Final Decision document selecting the remedy, a Corrective Measures Implementation (CMI) Plan will be needed. The CMI plan will include the following, at a minimum:

a. A description of the conceptual design, technical features (e.g., plans and specifications, including any treatability studies) and a construction plan for the selected remedy(ies);
b. A proposed schedule that takes into account all phases of the CMI. The schedule should also include the submittal of documents to support the CMI; and
c. Requirements for removal and decontamination of units, equipment, devices, and structures that will be used to implement the remedy(ies).

9.0 REFERENCES

ADEM, 2008 (Revision 2), *Alabama Risk-Based Corrective Action Guidance Manual*.

Arcadis and CH2M Hill. 2009. Phase III RCRA Facility Investigation (RFI). Sloss Industries, Birmingham, Alabama.

Schaum, J., K. Hoang, R. Kinerson, J. Moya, and R.G.M. Wang. 1994. Estimating Dermal and Inhalation Exposure to Volatile Chemicals in Domestic Water. Ch. 13 in: Water Contamination and Health, R.G.M. Wang ed., Marcel Dekker, Inc., New York, NY.

US Environmental Protection Agency (USEPA). 2013a. *Regional Screening Levels (RSLs).* Available on-line: http://www.epa.gov/region9/superfund/prg/rsl-table.html.

U.S. EPA 2015a. Regional Screening Levels for Chemical Contaminants at Superfund Sites, Interagency Agreement between EPA Office of Superfund and Oak Ridge National Laboratory, June 2015.
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

U.S. EPA 2014b. Region 4 Human Health Risk Assessment Supplemental Guidance, Technical Services Section, Superfund Division, EPA Region 4, Website version last updated June 2014.
http://www.epa.gov/region4/superfund/images/allprogrammedia/pdfs/hhraguidedoc011014.pdf

U.S. EPA 2014c. OSWER Memo, Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, February 6, 2014. http://www.epa.gov/oswer/riskassessment/pdf/superfund-hh-exposure/OSWER-Directive-9200-1-120-ExposureFactors.pdf

USEPA. 2013b. Vapor Intrusion Screening Level (VISL) Calculator version 3.2. Office of Solid Waste Vapor Intrusion Assessment, Washington, D.C.

USEPA. 2013c. *Integrated Risk Information System* (IRIS). Current, on-line database, http://www.epa.gov/iris.

U.S. EPA 2011b. U.S. EPA Exposure Factors Handbook 2011 Edition (Final). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-09/052F, 2011.
http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252

USEPA. 2011. ProUCL Version 4.1.01. Office of Research and Development, Washington, DC.

USEPA. 2009. *Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*. EPA-540-R-070-002, OSWER 9285.7-82. Office of Superfund Remediation and Technology Innovation, Washington, DC.

USEPA. 2005. *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposures to Carcinogens*. EPA/630/R-03/003F. Risk Assessment Forum. Washington, DC.

USEPA. 2004. *RAGS, Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).* EPA/540/R/99/005, OSWER 9285.7-02EP, PB99-963312. Office of Superfund Remediation and Technology Innovation, Washington, DC.

U.S. EPA 2003, 1996. *Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* [EPA-540-R-03-001, OSWER Dir #9285.7-54]; EPA # added January 2003, originally published December 1996.

USEPA. 2003. *Human Health Toxicity Values in Superfund Risk Assessment.* OSWER Directive 9285.7-53. Office of Solid Waste and Emergency Response, Washington, D.C.

USEPA. 2002a. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.* OSWER 9355.4-24. Office of Solid Waste and Emergency Response. Washington, DC.

USEPA. 2002b. *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils*. EPA530-D-02-004 . Office of Emergency and Remedial Response. Washington, DC.

U.S. EPA 2000. FACT SHEET #2 – Expectations for Final Remedies at RCRA Corrective Action Facilities. http://www.epa.gov/osw/hazard/correctiveaction/pdfs/workshop/expect.pdf

U.S. EPA 2000. FACT SHEET #3 – Final Remedy Selection for Results-Based RCRA Corrective Action. http://www.epa.gov/osw/hazard/correctiveaction/pdfs/workshop/select.pdf

U.S. EPA 1997. Rules of Thumb for Superfund Remedy Selection, OSWER 9355.0-69. http://www.epa.gov/superfund/policy/remedy/rules/rulesthm.pdf

USEPA. 1997. *Exposure Factors Handbook*. EPA/600/R-09/052F. National Center for Environmental Exposure (NCEA). Office of Research and Development. Washington, DC.

USEPA. 1996. ANPR: *Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities*. Federal Register/Vol. 61, No. 85. RIN 2050-AB80. Washington, DC.

USEPA. 1993. *Presumptive Remedies: Policies and Procedures* Office ofSolid Waste and Emergency Response. EPA540-F-93-047. Washington, DC. http://www.epa.gov/oerrpage/superfund/policy/remedy/presump/pol.htm

USEPA. 1992. *Supplemental Guidance to RAGS: Calculating the Concentration Term*. Publication 9285.7-081. Office of Solid Waste and Emergency Response. Washington, DC.

U.S. EPA 1991. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions, OSWER DIRECTIVE 9355.0-30. http://www.epa.gov/oswer/riskassessment/pdf/baseline.pdf

USEPA. 1991. *RAGS, Part B: Development of Risk-Based Preliminary Remediation Goals*. EPA/540/R-92/003. Office of Emergency and Remedial Response. Washington, DC.

USEPA. 1991. *RAGS, Volume 1: Human Health Evaluation Manual, Supplemental Guidance, "Standard Default Exposure Factors",* Interim Final. OSWER Directive 9285.6-03, March 25, 1991.

USEPA. 1990. *National Contingency Plan*. 40 Code of Federal Regulations, Part 300. Washington, DC.

USEPA. 1989. *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual* (Part A). EPA/540/1-89/002. Office of Emergency and Remedial Response. Washington, DC.

USEPA Region 4. 2000. *Supplemental Guidance to RAGs, Region 4 Bulletins, Human Health Risk Assessment Bulletins*. EPA Region 4, Website version last updated May 2000. (http://www.epa.gov/region4/waste/oftecser/healtbul.htm).

U.S. EPA. Region 4 Region 4 Office of Quality Assurance and Data Integration QAPP Review Checklist

Virginia Department of Environmental Quality (VDEQ). 2010. *Voluntary Remediation Program Risk Assessment Guidance*. Available online: http://www.deq.virginia.gov/vrprisk/raguide.html.

Table 3-1
SMA-5 - Surface Soil Analytical Results for Chemicals Detected at Least Once, 0 to 1 ft
Statistical Summary and Selection of Chemicals of Potential Concern (COPCs)
ERP Coke Facility, Birmingham, Alabama

	Sample ID:	**SB44001**	**SB44002**	**SB44003**	**SB45001**	**SB45003**					**Screening**		
	Sample depth:	**0-1**	**0-1**	**0-1**	**0-1**	**0-1**					**Values**		
	Sample date:	**6/16/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**	**Number of**		**Concentration**		**Industrial**		
ParameterName	**CAS Number**						**Samples**	**Detections**	**Min**	**Max**	**RSLs[1]**	**COPC?**	**Reason**
VOLATILE ORGANIC CHEMICALS (mg/kg)													
Methylene chloride	75-09-2	0.002 u	0.0017 u	**0.0022 j**	0.0019 u	0.0016 u	5	1	0.0016 u	0.0022 j	350	No	4
o-Xylene	95-47-6	0.00076 u	**0.00099 j**	0.00063 u	0.00074 u	0.0006 u	5	1	0.0006 u	0.00099 j	280	No	4
SEMIVOLATILE ORGANIC CHEMICALS (mg/kg)													
2-Methylnaphthalene	91-57-6	**0.11**	**0.35**	**0.58**	**0.29**	**0.56**	5	5	0.11	0.58	300	No	4
Acenaphthene	83-32-9	**0.027**	**0.045**	**0.042**	**0.059**	**0.048**	5	5	0.027	0.059	4500	No	4
Acenaphthylene	208-96-8	**0.1**	**0.12**	**0.11**	**0.27**	**0.091**	5	5	0.091	0.27	2300	No	4
Anthracene	120-12-7	**0.088**	**0.24**	**0.27**	**0.33**	**0.29**	5	5	0.088	0.33	23000	No	4
Benz(a)anthracene	56-55-3	**0.26**	**1.1**	**0.89**	**1**	**0.57**	5	5	0.26	1.1	2.9	Yes	5
Benzo(a)pyrene	50-32-8	**0.37**	**1.1**	**0.93**	**0.88**	**0.57**	5	5	0.37	1.1	0.29	Yes	3
Benzo(b)fluoranthene	205-99-2	**0.59**	**1.8**	**1.4**	**1.6**	**1.1**	5	5	0.59	1.8	2.9	Yes	5
Benzo(g,h,i)perylene	191-24-2	**0.34**	**0.83**	**0.77**	**0.61**	**0.46**	5	5	0.34	0.83	2300 [2]	No	4
Benzo(k)fluoranthene	207-08-9	**0.22**	**0.64**	**0.39**	**0.48**	**0.33**	5	5	0.22	0.64	29	Yes	5
bis(2-Ethylhexyl)phthalate	117-81-7	**0.097 j**	**0.12 j**	**0.64 j**	0.25 u	**1.1 j**	5	4	0.097	1.1 j	160	No	4
Carbazole	86-74-8	0.039 u	**0.052 j**	0.19 u	0.19 u	0.2 u	5	1	0.052 j	0.052 j	--	Yes	3
Chrysene	218-01-9	**0.34**	**1.5**	**1.5**	**1.4**	**1.3**	5	5	0.34	1.5	290	Yes	5
Dibenz(a,h)anthracene	53-70-3	**0.13**	**0.3**	**0.3**	**0.24**	**0.15**	5	5	0.13	0.3	0.29	Yes	3
Dibenzofuran	132-64-9	**0.022 j**	**0.056 j**	**0.17 j**	**0.13 j**	**0.2 j**	5	5	0.022	0.2 j	100	No	4
Dimethyl phthalate	131-11-3	**0.05 j**	**0.031 j**	0.12 u	0.12 u	0.13 u	5	2	0.031	0.031 j	66000 [3]	No	3
Di-n-Octyl phthalate	117-84-0	0.016 u	0.015 u	0.077 u	**0.63 j**	0.082 u	5	1	0.015	0.63 j	820	No	4
Fluoranthene	206-44-0	**0.39**	**1.3**	**1**	**1.6**	**0.9**	5	5	0.39	1.6	3000	No	4
Fluorene	86-73-7	**0.017**	**0.058**	**0.077**	**0.093**	**0.12**	5	5	0.017	0.12	3000	No	4
Indeno(1,2,3-cd)pyrene	193-39-5	**0.32**	**0.74**	**0.62**	**0.67**	**0.45**	5	5	0.32	0.74	2.9	Yes	5
Naphthalene	91-20-3	**0.32**	**0.43**	**0.73**	**0.5**	**0.62**	5	5	0.32	0.73	17	No	4
Phenanthrene	85-01-8	**0.22**	**1.1**	**1.1**	**0.96**	**0.99**	5	5	0.22	1.1	2300 [2]	No	4
Pyrene	129-00-0	**0.33**	**1.1**	**1**	**1.3**	**0.88**	5	5	0.33	1.3	2300	No	4
INORGANIC CHEMICALS (mg/kg)													
Arsenic	7440-38-2	**11**	**5.8**	**9.2**	**14**	**7.1**	5	5	5.8	14	3	Yes	3
Barium	7440-39-3	**120**	**290**	**120**	**100**	**200**	5	5	100	290	22000	No	4
Cadmium	7440-43-9	**0.39 j**	**0.62**	**0.5 j**	**0.39 j**	**0.17 j**	5	5	0.17 j	0.62	98	No	4
Chromium	7440-47-3	**15**	**20**	**29**	**23**	**23**	5	5	15	29	6.3	Yes	3
Lead	7439-92-1	**27**	**34**	**26**	**13**	**18**	5	5	13	34	800	No	4
Selenium	7782-49-2	0.81 u	**1.8**	**1.1 j**	0.83 u	**3.4**	5	3	0.81 u	3.4	580	No	4
Silver	7440-22-4	**0.18** j	**0.59 j**	**0.26 j**	**0.34 j**	**0.49 j**	5	5	0.18 j	0.59 j	580	No	4
Mercury	7439-97-6	**0.19**	**0.36**	**1**	**0.17**	**0.082**	5	5	0.082	1	4	No	4

u = qualifier code for nondetected result — COPC = chemical of potential concern

j = qualifier code for estimated result — **BOLD** font indicates a detected chemical concentration.

[1]USEPA, June 2015. Regional Screening Levels (RSLs). Concentrations selected for RSLs are the lower value of the carcinogenic RSL (derived at 1E-06 carcinogenic risk) or noncarcogenic RSL (derived at 0.1 hazard quotient).

[2]No published RSL exists for this chemical; hence, the RSL for pyrene is used as a surrogate concentration.

[3]No published RSL exists for this chemical; hence the RSL for diethyl phthalate is used as a surrogate concentration.

A = Retained as a COPC because the maximum concentration exceeds the RSL, or a published RSL is not available

B = Excluded as a COPC because the maximum concentration is less than the RSL

C = Retained as a COPC because it is included in the group of potentially carcinogenic PAHs, and at least one in that group has exceeded its screening level.

Table 3-2
SMA-5, Subsurface Soil Analytical Results for Chemicals Detected at Least Once - 0 - 9 ft
Statistical Summary and Selection of Chemicals of Potential Concern (COPCs)
ERP Coke Facility, Birmingham, Alabama

	Sample ID:	SB43001	SB43001	SB43001	SB43002	SB43002	SB43002	SB43003	SB43003	SB43003	SB44001	SB44001	SB44001	SB44002	SB44002	SB44002	SB44003	SB44003	SB44003
	Sample depth:	1-3	5-7	7-9	1-3	3-5	7-9	1-3	3-5	5-7	0-1	1-3	3-5	0-1	1-3	3-5	0-1	1-3	3-5
	Sample date:	6/17/2014	06/17/14	6/17/2014	6/17/2014	6/17/2014	6/17/2014	6/17/2014	6/17/2014	6/17/2014	6/16/2014	6/16/2014	6/16/2014	6/16/2014	6/16/2014	6/16/2014	6/16/2014	6/16/2014	6/16/2014
ParameterName	**CASNumber**																		
VOLATILE ORGANIC CHEMICALS (mg/kg)																			
1,2,3-Trichlorobenzene	87-61-6	0.0027 j	0.00099 u	0.00098 u	0.0012 u	0.001 u	0.001 u	0.00086 u	0.0012 u	0.001 u	0.00093 u	0.00092 u	0.042 u	0.00079 u	0.00097 u	0.00089 u	0.00077 u	0.0011 u	0.0008 u
1,2,4-Trichlorobenzene	120-82-1	0.0021 j	0.00096 u	0.00095 u	0.0011 u	0.001 u	0.001 u	0.00084 u	0.0012 u	0.001 u	0.00091 u	0.00089 u	0.057 u	0.00077 u	0.00094 u	0.00087 u	0.00075 u	0.0011 u	0.00078 u
Acetone	67-64-1	0.027	0.04	0.017 j	0.0084 u	0.0075 u	0.0083 j	0.0062 u	0.0088 u	0.041	0.0067 u	0.0066 u	0.48 u	0.0056 u	0.0069 u	0.0064 u	0.0056 u	0.0079 u	0.016 j
Benzene	71-43-2	0.00062 u	0.001 j	0.00061 u	0.00074 u	0.00066 u	0.00065 u	0.00054 u	0.00077 u	0.0012 j	0.00058 u	0.00057 u	0.35	0.00049 u	0.00061 u	0.00056 u	0.00048 u	0.00079 j	0.0013 j
Carbon disulfide	75-15-0	0.00055 u	0.00055 u	0.00055 u	0.00066 u	0.00059 u	0.00058 u	0.00048 u	0.00069 u	0.00059 u	0.00052 u	0.00051 u	0.077 u	0.00044 u	0.00054 u	0.0005 u	0.00043 u	0.00062 u	0.00045 u
Ethylbenzene	100-41-4	0.00088 u	0.00088 u	0.00087 u	0.0011 u	0.00094 u	0.00092 u	0.00077 u	0.0011 u	0.0016 j	0.00083 u	0.00082 u	0.56	0.0007 u	0.00086 u	0.00079 u	0.00069 u	0.0037 j	0.00072 u
Isopropylbenzene	98-82-8	0.00077 u	0.00078 u	0.00077 u	0.00093 u	0.00082 u	0.00081 u	0.00068 u	0.00096 u	0.00082 u	0.00073 u	0.00072 u	0.32	0.00062 u	0.00076 u	0.0007 u	0.00061 u	0.00086 u	0.00063 u
Methylene chloride	75-09-2	0.0021 u	0.0055 j	0.0046 j	0.0053 j	0.0062 j	0.0028 j	0.0018 u	0.0026 u	0.0053 j	0.002 u	0.002 u	0.084 u	0.0017 u	0.0021 u	0.0019 u	0.0022 j	0.0033 j	0.0018 j
m-Xylene & p-Xylene	136777-61-2	0.0014 u	0.0014 u	0.0014 u	0.0016 u	0.0015 u	0.0014 u	0.0012 u	0.0017 u	0.0026 j	0.0013 u	0.0013 u	2.8	0.0011 u	0.0013 u	0.0012 u	0.0011 u	0.013	0.0011 u
o-Xylene	95-47-6	0.0008 u	0.0008 u	0.0008 u	0.00096 u	0.00085 u	0.00084 u	0.0007 u	0.001 u	0.0024 j	0.00076 u	0.00074 u	3	0.00099 j	0.00079 u	0.00072 u	0.00063 u	0.0045	0.00065 u
Toluene	108-88-3	0.00091 u	0.00091 u	0.0009 u	0.0011 u	0.00096 u	0.00095 u	0.00079 u	0.0011 u	0.0019 j	0.00086 u	0.00084 u	1.1	0.00072 u	0.00089 u	0.00082 u	0.00071 u	0.0089	0.00074 u
SEMIVOLATILE ORGANIC CHEMICALS (mg/kg)																			
2-Methylnaphthalene	91-57-6	1.4	0.14	0.36	0.69	1.4	0.27	1.1	0.74	0.28	0.11	0.17	40	0.35	0.94	0.12	0.58	0.61	0.78
Acenaphthene	83-32-9	1.3	0.18	0.93	0.092	0.3	0.097	0.14	0.069	0.23	0.027	0.073	3.7	0.045	0.14	0.029	0.042	0.42	0.31
Acenaphthylene	208-96-8	0.6	0.19	1.8	0.33	0.19	1.1	0.41	0.15	1.6	0.1	0.2	4.3	0.12	0.5	0.13	0.11	0.099	0.58
Acetophenone	98-86-2	0.12 u	0.11 u	0.12 u	0.12 u	0.12 u	0.12 u	0.12 u	0.027 u	0.11 u	0.022 u	0.022 u	0.11 u	0.021 u	0.11 u	0.024 u	0.11 u	0.12 u	0.13 j
Anthracene	120-12-7	0.86 j	0.56 j	1.4 j	0.41 j	0.87 j	0.59 j	0.58 j	0.4 j	1.7 j	0.077 j	0.096 j	19	0.12 j	0.92 j	0.12 j	0.25 j	0.89 j	0.98 j
Anthracene	120-12-7	1	0.41 j	1.3	0.39	0.85	0.58	0.76	0.32	1	0.088	0.15	12	0.24	0.92	0.21	0.27	0.68	0.96
Benz(a)anthracene	56-55-3	3.7	2.9	5.9	1.6	1.4	3.2	1.5	0.77	6.8	0.26	0.65	12	1.1	3	0.75	0.89	5.3	1.5
Benzo(a)pyrene	50-32-8	4.4	4.7	8.6	1.8	1.1	4.2	1.5	0.79	9.1	0.37	0.81	8.6	1.1	2.6	0.76	0.93	10	1.3
Benzo(b)fluoranthene	205-99-2	7.4	8.2	13	3	2.1	6.9	3	1.5	15	0.59	1.4	13	1.8	4.2	1.2	1.4	14	2.1
Benzo(g,h,i)perylene	191-24-2	2.8	4.7	7.4	1.2	0.79	3.4	1	0.54	8	0.34	0.68	5.2	0.83	1.6	0.53	0.77	8.8	0.87
Benzo(k)fluoranthene	207-08-9	2.6	2.6	4.7	1.1	0.61	2.2	1.1	0.51	5.3	0.22	0.5	4.7	0.64	1.5	0.42	0.39	4.9	0.79
bis(2-Ethylhexyl)phthalate	117-81-7	0.58 j	0.26 u	0.27 u	0.28 u	0.71 j	0.28 u	0.66 j	0.23 j	0.26 u	0.097 j	0.051 u	0.26 u	0.12 j	0.25 u	0.055 u	0.64 j	0.27 u	0.27 u
Butyl benzyl phthalate	85-68-7	0.27 u	0.24 u	0.25 u	0.26 u	0.26 u	0.27 u	0.26 u	0.095 j	0.24 u	0.047 u	0.048 u	0.25 u	0.046 u	0.23 u	0.052 u	0.23 u	0.25 u	0.26 u
Carbazole	86-74-8	0.41 j	0.21 j	0.6 j	0.22 u	0.25 j	0.23 j	0.28 j	0.16 j	0.46 j	0.039 u	0.043 j	6.3	0.052 j	0.46 j	0.056 j	0.19 u	1.1 j	0.21 u
Chrysene	218-01-9	5.1	4	7.9	2.1	2.5	4.1	2.2	1.2	8.5	0.34	0.82	12	1.5	3.6	0.98	1.5	8.1	1.7
Dibenz(a,h)anthracene	53-70-3	1.1	1.5	2.2	0.43	0.34	1.1	0.42	0.23	2.5	0.13	0.23	1.5 j	0.3	0.71	0.21	0.3	2.3	0.33
Dibenzofuran	132-64-9	0.38 j	0.16 j	0.45 j	0.16 j	0.82 j	0.15 j	0.33 j	0.25 j	0.29 j	0.022 j	0.036 j	27	0.056 j	0.33 j	0.026 j	0.17 j	0.22 j	0.55 j
Dimethyl phthalate	131-11-3	0.14 j	0.13 u	0.13 u	0.14 u	0.14 u	0.17 j	0.14 u	0.053 j	0.13 u	0.05 j	0.069 j	0.39 u	0.031 j	0.12 u	0.19 j	0.12 u	0.13 u	0.14 u
Di-n-octyl phthalate	117-84-0	0.09 u	0.082 u	0.084 u	0.087 u	0.086 u	0.089 u	0.086 u	0.019 u	0.081 u	0.016 u	0.016 u	0.082 u	0.015 u	0.078 u	0.017 u	0.077 u	0.084 u	0.086 u
Fluoranthene	206-44-0	4.7	3.5	8.4	2	2.7	4.3	2.4	1.3	10	0.39	0.97	36	1.3	3.5	0.94	1	7	3.8
Fluorene	86-73-7	0.57	0.2 j	0.65	0.096	0.39	0.13	0.26	0.11	0.36	0.017	0.043	23	0.058	0.4	0.071	0.077	0.24	0.98
Indeno(1,2,3-cd)pyrene	193-39-5	3	4.1	6.4	1.2	0.73	3.7	1.1	0.56	7.6	0.32	0.71	5.3	0.74	1.6	0.52	0.62	7.7	0.86
Naphthalene	91-20-3	3.1	0.029 u	2	1	1.3	0.69	1.5	1.2	1.4	0.32	0.45	210	0.43	3.4	0.25	0.73	0.71	7
Phenanthrene	85-01-8	3.3	1.6	3.7	1.2	3	1.4	2.3	1.4	4	0.22	0.5	54	1.1	3	0.61	1.1	2.9	2.7
Pyrene	129-00-0	4.4	3.1	6.7	1.9	2.2	3.8	2.1	1	8.3	0.33	0.9	23	1.1	2.9	0.78	1	6.6	2.7
INORGANIC CHEMICALS (mg/kg)																			
Arsenic	7440-38-2	22	3.8	8.8	13	7.4	14	21	18	25	11	24	10	5.8	13	15	9.2	10	10
Barium	7440-39-3	230	37	52	270	240	160	220	190	100	120	160	63	290	220	150	120	210	79
Cadmium	7440-43-9	4.6	0.77	0.58	3.1	0.46 j	1.4	2.6	2.3	1.9	0.39 j	0.8	0.05 u	0.62	2.3	0.29 j	0.5 j	1.3	0.32 j
Chromium	7440-47-3	88	7.5	19	81	21	41	49	55	40	15	25	30	20	29	54	29	31	20
Lead	7439-92-1	300	28	45	240	29	98	150	170	140	27	46	16	34	820	30	26	90	32
Selenium	7782-49-2	9.8 u	0.93 u	2.4	9.5 u	1.6	0.98 u	1.1 j	1.1 u	1.9	0.81 u	0.86 u	1 u	1.8	1.6	1.5	1.1 j	1 u	0.99 u
Silver	7440-22-4	5.4	0.27 j	0.22 j	1.6	0.48 j	0.69 j	1 j	1.2 j	0.54 j	0.18 j	0.8 j	0.19 u	0.59 j	0.65 j	0.52 j	0.26 j	0.84 j	0.22 j
Mercury	7439-97-6	0.77	0.71	4.6	0.45	0.13	2.5	0.29	0.31	2.9	0.19	0.28	0.1	0.36	5	0.17	1	0.36	0.25

Table 3-2
SMA-5, Subsurface Soil Analytical Results for Chemicals Detected at Least Once - 0 - 9 ft
Statistical Summary and Selection of Chemicals of Potential Concern (COPCs)
ERP Coke Facility, Birmingham, Alabama

	Sample ID:	**SB45001**	**SB45001**	**SB45001**	**SB45002**	**SB45002**	**SB45003**	**SB45003**	**SB45004**					**Screening**		
	Sample depth:	**0-1**	**1-3**	**3-5**	**1-3**	**3-5**	**0-1**	**1-2.5**	**1-2.5**					**Value**		
	Sample date:	**6/16/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**	**Number of**		**Concentration**		**Industrial**		
ParameterName	**CASNumber**									**Samples**	**Detections**	**Min**	**Max**	**RSL[1]**	**COPC?**	**Reason**
VOLATILE ORGANIC CHEMICALS (mg																
1,2,3-Trichlorobenzene	87-61-6	0.00091 u	0.001 u	0.00092 u	0.00073 u	0.00092 u	0.00074 u	0.00074 u	0.001 u	26	1	0.00073 u	0.0027 j	93	No	B
1,2,4-Trichlorobenzene	120-82-1	0.00089 u	0.00097 u	0.0009 u	0.00071 u	0.0009 u	0.00072 u	0.00072 u	0.001 u	26	1	0.00071 u	0.0021 j	26	No	B
Acetone	67-64-1	0.0065 u	**0.0098 j**	0.0066 u	0.0053 u	0.0066 u	0.0053 u	0.0053 u	**0.018 j**	26	8	0.0053 u	0.041	67000	No	B
Benzene	71-43-2	0.00057 u	**0.0054 j**	0.00058 u	0.00046 u	0.00058 u	0.00047 u	0.00047 u	0.00065 u	26	6	0.00046 u	0.35	5.1	No	B
Carbon disulfide	75-15-0	0.00051 u	**0.0031 j b**	0.00052 u	0.00041 u	0.00052 u	0.00042 u	0.00042 u	0.00058 u	26	1	0.00041 u	0.0031 j b	350	No	B
Ethylbenzene	100-41-4	0.00082 u	0.00089 u	0.00083 u	0.00066 u	0.00083 u	0.00066 u	0.00066 u	0.00092 u	26	3	0.00066 u	0.56	25	No	B
Isopropylbenzene	98-82-8	0.00072 u	0.00079 u	0.00073 u	0.00058 u	0.00073 u	0.00058 u	0.00059 u	0.00081 u	26	1	0.00058 u	0.32	990	No	B
Methylene chloride	75-09-2	0.0019 u	**0.0027 j**	0.002 u	0.0016 u	0.002 u	0.0016 u	0.0016 u	**0.0028 j**	26	11	0.0016 u	0.084	320	No	B
m-Xylene & p-Xylene	136777-61-2	0.0013 u	**0.0028 j**	0.0013 u	0.001 u	0.0013 u	0.001 u	0.001 u	**0.0017 j**	26	5	0.001 u	2.8	240	No	B
o-Xylene	95-47-6	0.00074 u	**0.0019 j**	0.00075 u	0.0006 u	0.00075 u	0.0006 u	0.00061 u	**0.0014 j**	26	6	0.0006 u	3	280	No	B
Toluene	108-88-3	0.00084 u	**0.002 j**	0.00085 u	0.00068 u	0.00085 u	0.00068 u	0.00068 u	0.00095 u	26	4	0.00068 u	1.1	4700	No	B
SEMIVOLATILE ORGANIC CHEMICAL																
2-Methylnaphthalene	91-57-6	**0.29**	**0.95**	**0.086**	**0.37**	**0.067**	**0.56**	**0.25**	**0.19**	26	26	0.067	40	300	No	B
Acenaphthene	83-32-9	**0.059**	**0.42**	**0.079**	**0.52**	**0.045**	**0.048**	**0.028**	**0.018**	26	26	0.018	3.7	4500	No	B
Acenaphthylene	208-96-8	**0.27**	**6**	**0.28**	**0.026 j**	**0.036**	**0.091**	**0.039**	**0.018**	26	26	0.018	6	2300 [2]	No	B
Acetophenone	98-86-2	0.11 u	**0.37 j**	0.023 u	0.11 u	0.11 u	0.11 u	0.022 u	0.026 u	26	2	0.021 u	0.37 j	12000	No	B
Anthracene	120-12-7	**0.26 j**	**4.9**	**0.26 j**	**1 j**	**0.14 j**	**0.29 j**	**0.11 j**	**0.11 j**	26	26	0.077	19	23000	No	B
Anthracene	120-12-7	**0.33**	**5**	**0.22**	0.39 u	**0.15**	**0.29**	**0.14**	**0.061**	26	25	0.061	12	23000 [2]	No	B
Benz(a)anthracene	56-55-3	**1**	**13**	**0.87**	**14**	**1.1**	**0.57**	**0.25**	**0.051**	26	26	0.051	14	2.9	Yes	A
Benzo(a)pyrene	50-32-8	**0.88**	**13**	**0.98**	**26**	**1.7**	**0.57**	**0.22**	**0.04**	26	26	0.04	26	0.29	Yes	A
Benzo(b)fluoranthene	205-99-2	**1.6**	**20**	**1.8**	**43**	**3**	**1.1**	**0.42**	**0.062**	26	26	0.062	43	2.9	Yes	A
Benzo(g,h,i)perylene	191-24-2	**0.61**	**9.3**	**0.74**	**27**	**1.5**	**0.46**	**0.17**	**0.03**	26	26	0.03	27	2300 [2]	No	B
Benzo(k)fluoranthene	207-08-9	**0.48**	**7.1**	**0.63**	**14**	**1**	**0.33**	**0.14**	**0.02**	26	26	0.02	14	29	Yes	C
bis(2-Ethylhexyl)phthalate	117-81-7	0.25 u	0.5 u	0.052 u	0.25 u	0.25 u	**1.1 j**	**0.34 j**	0.06 u	26	9	0.051 u	1.1	160	No	B
Butyl benzyl phthalate	85-68-7	0.23 u	0.47 u	0.049 u	0.23 u	0.23 u	0.24 u	0.047 u	0.057 u	26	1	0.046	0.095 j	1200	No	B
Carbazole	86-74-8	0.19 u	**1.2 j**	**0.11 j**	**0.4 j**	0.19 u	0.2 u	**0.048 j**	0.047 u	26	18	0.039	6.3	--	Yes	A
Chrysene	218-01-9	**1.4**	**15**	**1.1**	**20**	**1.6**	**1.3**	**0.44**	**0.056**	26	26	0.056	20	290	Yes	C
Dibenz(a,h)anthracene	53-70-3	**0.24**	**3**	**0.25**	**7.9**	**0.45**	**0.15**	**0.076**	**0.0095**	26	26	0.0095	7.9	0.29	Yes	A
Dibenzofuran	132-64-9	**0.13 j**	**1.2 j**	**0.059 j**	**0.3 j**	0.11 u	**0.2 j**	**0.085 j**	**0.081 j**	26	25	0.022 j	27	100	No	B
Dimethyl phthalate	131-11-3	0.12 u	0.25 u	**0.17 j**	0.13 u	0.12 u	0.13 u	**0.083 j**	0.03 u	26	9	0.03 u	0.17 j	66000 [3]	No	B
Di-n-octyl phthalate	117-84-0	**0.63 j**	0.16 u	0.016 u	0.079 u	0.077 u	0.082 u	0.016 u	0.019 u	26	1	0.015 u	0.63	820	No	B
Fluoranthene	206-44-0	**1.6**	**27**	**1.7**	**13**	**1.2**	**0.9**	**0.43**	**0.14**	26	26	0.14	36	3000	No	B
Fluorene	86-73-7	**0.093**	**1.7**	**0.076**	**0.6**	**0.046**	**0.12**	**0.073**	**0.083**	26	26	0.017	23	3000	No	B
Indeno(1,2,3-cd)pyrene	193-39-5	**0.67**	**12**	**0.77**	**24**	**1.6**	**0.45**	**0.15**	**0.03**	26	26	0.03	24	2.9	Yes	A
Naphthalene	91-20-3	**0.5**	**5.8**	**0.48**	**0.49**	**0.098**	**0.62**	**0.25**	**0.67**	26	25	0.029 u	210	17	Yes	A
Phenanthrene	85-01-8	**0.96**	**10**	**0.85**	**4.7**	**0.45**	**0.99**	**0.51**	**0.21**	26	26	0.21	54	2300 [2]	No	B
Pyrene	129-00-0	**1.3**	**20**	**1.3**	**12**	**1.1**	**0.88**	**0.38**	**0.15**	26	26	0.15	23	2300	No	B
INORGANIC CHEMICALS (mg/kg)																
Arsenic	7440-38-2	**14**	**16**	**10**	**3.8**	**5.2**	**7.1**	**3.5**	**2 j**	26	26	2	25	3	Yes	A
Barium	7440-39-3	**100**	**130**	**94**	**27**	**360**	**200**	**380**	**350**	26	26	27	380	22000	No	B
Cadmium	7440-43-9	**0.39 j**	**0.51**	**0.58**	**0.15 j**	**0.18 j**	**0.17 j**	**0.086 j**	0.05 u	26	24	0.05 u	4.6	98	No	B
Chromium	7440-47-3	**23**	**23**	**26**	**7.1**	**25**	**23**	**28**	**22**	26	26	7.1	88	6.3	Yes	A
Lead	7439-92-1	**13**	**62**	**54**	**9**	**16**	**18**	**5.8**	**3.4**	26	26	3.4	820	800	Yes	A
Selenium	7782-49-2	0.83 u	0.85 u	0.99 u	0.81 u	**2.5**	**3.4**	**1.8**	**1.7**	26	12	0.81 u	9.8	580	No	B
Silver	7440-22-4	**0.34 j**	**0.28 j**	**0.53 j**	0.15 u	**0.48 j**	**0.49 j**	**0.64** j	**0.48 j**	26	24	0.15 u	5.4	580	No	B
Mercury	7439-97-6	**0.17**	**0.75**	**0.78**	**0.03**	**0.26**	**0.082**	**0.042**	0.008 u	26	25	0.008 u	5	4	Yes	A

u = qualifier code for nondetected result | b = qualifier code for blank contamination

j = qualifier code for estimated result | COPC = chemical of potential concern

BOLD font indicates a detected chemical concentration.

[1]USEPA, June 2015. Regional Screening Levels (RSLs). Concentrations selected for RSLs are the lower value of the carcinogenic RSL (derived at 1E-06 carcinogenic risk) or noncarcogenic RSL (derived at 0.1 hazard quotient).

[2]No published RSL exists for this chemical; hence, the RSL for pyrene is used as a surrogate concentration.

[3]No published RSL exists for this chemical; hence the RSL for diethyl phthalate is used as a surrogate concentration.

A = Retained as a COPC because the maximum concentration exceeds the RSL, or a published RSL is not available

B = Excluded as a COPC because the maximum concentration is less than the RSL

C = Retained as a COPC because it is included in the group of potentially carcinogenic PAHs, and at least one in that group has exceeded its screening level.

Table 3.3
SMA 5 - Summary of Human Exposure Assumptions[a]
Human Health Risk Assessment
ERP Coke Facility, Birmingham, Alabama

Exposure Pathway	Parameter	Industrial/Commercial Worker (Adult)	Construction Worker (Adult)	Parameter Units
General	Body weight (BW)	80	80	kg
	Exposure frequency (EF)	250	250	days/year
	Exposure duration (ED)	25	1	year
	Exposure time (ET)	8	8	hour/day
	Averaging time - Cancer[b] (AT_C)	25,550	25,550	days
	Averaging time - Noncancer[c] (AT_{NC})	9,125	365	days
Ingestion	Soil intake rate (IR_S)	50	330[d]	mg/day
Inhalation	Particle Emission Factor (PEF)[e]	5.70E+09	5.70E+09	m^3/kg
Dermal Absorption	Skin surface area available for contact (SSA) (includes: face, forearms, and hands)	3,470	3,470	cm^2
	Soil to skin adherence factor (SAF)	0.12	0.12	mg/cm^2

(a) Unless otherwise noted, all exposure parameters are obtained from USEPA, 2014. *Human Health Evalation Manual, Supplemental Guidance: Update ofStandard Default Exposure Factors*. OSWER Directive 9200.1-120.

(b) Averaging time of exposure for carcinogenic effects is calculated as follows:
70-year lifetime exposure (70 years x 365 days/year = 25,550 days)

(c) Averaging time for noncarcinogenic effects is calculated as follows: ED years x 365 days/year

(d) From: USEPA, Region 4. 2014. *Human Health Risk Assessment Supplemental Guidance.*

(e) From: USEPA, 2004. *RAGS Part E, Dermal Expsoure Guidance*.

Table 3.4
SMA 5 Soil, 0-1 ft, Human Health Risk Assessment
Chemicals of Potential Concern Exposure Point Concentrations
ERP Coke Facility, Birmingham, Alabama

Chemical Name	Maximum Concentration mg/kg	95% UCL mg/kg	EPC mg/kg
Benz(a)anthracene	1.1	1.09	1.09
Benzo(a)pyrene	1.1	1.05	1.05
Benzo(b)fluoranthene	1.8	1.75	1.75
Benzo(k)fluoranthene	0.64	0.56	0.56
Carbazole	0.052	na	0.052
Chrysene	1.5	1.68	1.5
Dibenz(a,h)anthracene	0.30	0.49	0.30
Indeno(1,2,3-cd)pyrene	0.74	0.72	0.72
Arsenic	14	12.5	12.5
Chromium	29	26.9	26.9

UCL = upper confidence limit, as calculated by ProUCL v.5.0 (USEPA, 2013)
EPC = exposure point concentration; the lesser of the maximum concentration or the UCL
na = not applicable; too few detections to calculate a 95% UCL.

Table 3.5
SMA 5 - Soil, 0-9 ft, Human Health Risk Assessment
Chemicals of Potential Concern Exposure Point Concentrations
ERP Coke Facility, Birmingham, Alabama

Chemical Name	Maximum Concentration mg/kg	95% UCL mg/kg	EPC mg/kg
Benz(a)anthracene	14	5.032	5.03
Benzo(a)pyrene	26	11.82	11.82
Benzo(b)fluoranthene	43	10.46	10.46
Benzo(k)fluoranthene	14	3.593	3.593
Carbazole	6.3	2.007	2.007
Chrysene	20	6.408	6.408
Dibenz(a,h)anthracene	7.9	2.905	2.905
Indeno(1,2,3-cd)pyrene	24	9.764	9.764
Naphthalene	210	59.59	59.59
Arsenic	25	13.79	13.79
Chromium	88	41.08	41.08
Mercury	5	2.521	2.521
Lead	820	96.24*	96.24*

UCL = upper confidence limit, as calculated by ProUCL
EPC = exposure point concentration, the lesser of the maximum concentration or the UCL
*Mean concentration

Table 3.6
Carcinogenic Oral and Dermal Toxicity Values
SMA 5 - ERP Coke Facility, Birmingham, AL

Chemicals of Potential Concern (COPCs)	Oral SF $(mg/kg\text{-}day)^{-1}$	Oral Absorption Efficiency for Dermal unitless	Dermal SF (mg/kg-day)	Weight of Evidence/ Cancer Guildeline Description	Oral SF Source
Benzo(a)anthracene	7.30E-01	1	7.3E-01	B2	IRIS
Benzo(a)pyrene	7.30E+00	1	7.3E+00	B2	IRIS
Benzo(b)fluoranthene	7.30E-01	1	7.3E-01	B2	IRIS
Benzo(k)fluoranthene	7.30E-02	1	7.3E-02	B2	IRIS
Carbazole	nd	1	nd	na	--
Chrysene	7.30E-03	1	7.3E-03	B2	IRIS
Dibenzo(a,h)anthracene	7.30E+00	1	7.3E+00	B2	IRIS
Indeno(1,2,3-cd)pyrene	7.30E-01	1	7.3E-01	B2	IRIS
Naphthalene	nd	nd	nd	C	IRIS
Arsenic	1.50E+00	1	1.50E+00	A	IRIS
Chromium (as VI)	5.00E-01	0.025	2.00E+01	D	IRIS
Mercury	nd	nd	nd	D	IRIS

na = not applicable
nd = no data
PPRTV = Provisional Peer Review Toxicity Values for Superfund; http://www.hhpprtv.ornl.gov/index.html
IRIS = Integrated Risk Information System; accessed at http://www.epa.gov/iris
ATSDR = Agency for Toxic Substances and Disease Registry; http://www.atsdr.cdc.gov/az/a.html
CalEPA = California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA); http://www.oehha.ca.gov/tcdb/
USEPA RSLs = US Environmental Protection Agency Regional Screening Levels; http://www.epa.gov/region9/superfund/prg/index.html

Carcinogenic Categories:
A = Carcinogenic to humans, adequate human data
B = Probably carcinogenic to humans, sufficient evidence from animal data
C = Possibly carcinogenic to humans, limited animal evidence
D = Not classifiable as to human carcinogenicity

Table 3.7
Carcinogenic Inhalation Toxicity Values
SMA 5 - ERP Coke Facility, Birmingham, AL

Chemicals of Potential Concern (COPCs)	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Weight of Evidence/ Cancer Guildeline Description	Unit Risk Source
Benzo(a)anthracene	1.10E-04	B2/2A	CalEPA
Benzo(a)pyrene	1.10E-03	B2/2A	CalEPA
Benzo(b)fluoranthene	1.10E-04	B2/2B	CalEPA
Benzo(k)fluoranthene	1.10E-04	B2/2B	CalEPA
Carbazole	nd	na	--
Chrysene	1.10E-05	B2/3	CalEPA
Dibenzo(a,h)anthracene	1.20E-03	B2	CalEPA
Indeno(1,2,3-cd)pyrene	1.10E-04	B2	CalEPA
Naphthalene	3.40E-05	C	CalEPA/IRIS
Arsenic	4.30E-03	A	IRIS
Chromium	8.40E-02	A	USEPA-RSLs
Mercury	nd	D	IRIS

nd = no data
na = not applicable
PPRTV = Provisional Peer Review Toxicity Values for Superfund; http://www.hhpprtv.ornl.gov/index.html
IRIS = Integrated Risk Information System; accessed at http://www.epa.gov/iris
ATSDR = Agency for Toxic Substances and Disease Registry; http://www.atsdr.cdc.gov/az/a.html
CalEPA = California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA); http://www.oehha.ca.gov/tcdb/
USEPA RSLs = US Environmental Protection Agency Regional Screening Levels; http://www.epa.gov/region9/superfund/prg/index.html

Carcinogenic Categories:
A = Carcinogenic to humans, adequate human data
B = Probably carcinogenic to humans, sufficient evidence from animal data
C = Possibly carcinogenic to humans, limited animal evidence
D = Not classifiable as to human carcinogenicity

Table 3.8
Noncarcinogenic Oral and Dermal Toxicity Values
SMA 5 - ERP Coke Facility, Birmingham, AL

Chemicals of Potential Concern (COPCSs)	Oral Reference Dose (RfD) (mg/kg-day)	Gastrointestinal Absorption Efficiency (%)	Default Dermal RfD mg/kg-day	Primary Target Organ(s)	Uncertainty/ Modifying Factor	Source
Benzo(a)anthracene	nd	1	nd	na	--	--
Benzo(a)pyrene	nd	1	nd	na	--	--
Benzo(b)fluoranthene	nd	1	nd	na	--	--
Benzo(k)fluoranthene	nd	1	nd	na	--	--
Carbazole	nd	1	nd	na	--	--
Chrysene	nd	1	nd	na	--	--
Dibenzo(a,h)anthracene	nd	1	nd	na	--	--
Indeno(1,2,3-cd)pyrene	nd	1	nd	na	--	--
Naphthalene	2.00E-02	1	2.00E-02	Body weight	3,000	IRIS
Arsenic	3.00E-04	0.03	9.00E-06	Skin	3	IRIS
Chromium	3.00E-03	1	3.00E-03	na	900	IRIS
Mercury	nd	nd	nd	na	--	--

nd = no data
na = not applicable
PPRTV = Provisional Peer Review Toxicity Values for Superfund; http://www.hhpprtv.ornl.gov/index.html
IRIS = Integrated Risk Information System; accessed at http://www.epa.gov/iris
HEAST = Health Effects Assessment Summary Tables;
ATSDR = Agency for Toxic Substances and Disease Registry; http://www.atsdr.cdc.gov/az/a.html
CalEPA = California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA); http://www.oehha.ca.gov/tcdb/
USEPA RSLs = US Environmental Protection Agency Regional Screening Levels; http://www.epa.gov/region9/superfund/prg/index.html

Table 3.9
Noncarcinogenic Inhalation Values
SMA 5 - ERP Coke Facility, Birmingham, AL

Chemicals of Potential Concern (COPCSs)	Inhalation Reference Concentration RfC (mg/m^3)	RfC ($\mu g/m^3$)	Primary Target Organ(s)	Uncertainty/ Modifying Factor	Source
Benzo(a)anthracene	nd	nd	na	--	--
Benzo(a)pyrene	nd	nd	na	--	--
Benzo(b)fluoranthene	nd	nd	na	--	--
Benzo(k)fluoranthene	nd	nd	na	--	--
Carbazole	nd	nd	na	--	--
Chrysene	nd	nd	na	--	--
Dibenzo(a,h)anthracene	nd	nd	na	--	--
Indeno(1,2,3-cd)pyrene	nd	nd	na	--	--
Naphthalene	3.00E-03	3.00E+00	Nasal	3000	IRIS
Arsenic	1.50E-05	1.50E-02	Cardiovascular		CalEPA
Chromium	1.00E-04	1.00E-01	Nasal	90	IRIS
Mercury	3.00E-04	3.00E-01	Central nervous system	30	IRIS

nd = no data

na = not applicable

PPRTV = Provisional Peer Review Toxicity Values for Superfund; http://www.hhpprtv.ornl.gov/index.html

IRIS = Integrated Risk Information System; accessed at http://www.epa.gov/iris

CalEPA = California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA); http://www.oehha.ca.gov/tcdb/

Table 3.10
SMA 5 - Risk Characterization Summary
Receptors Exposed to Soil
ERP Coke Facility, Birmingham, AL

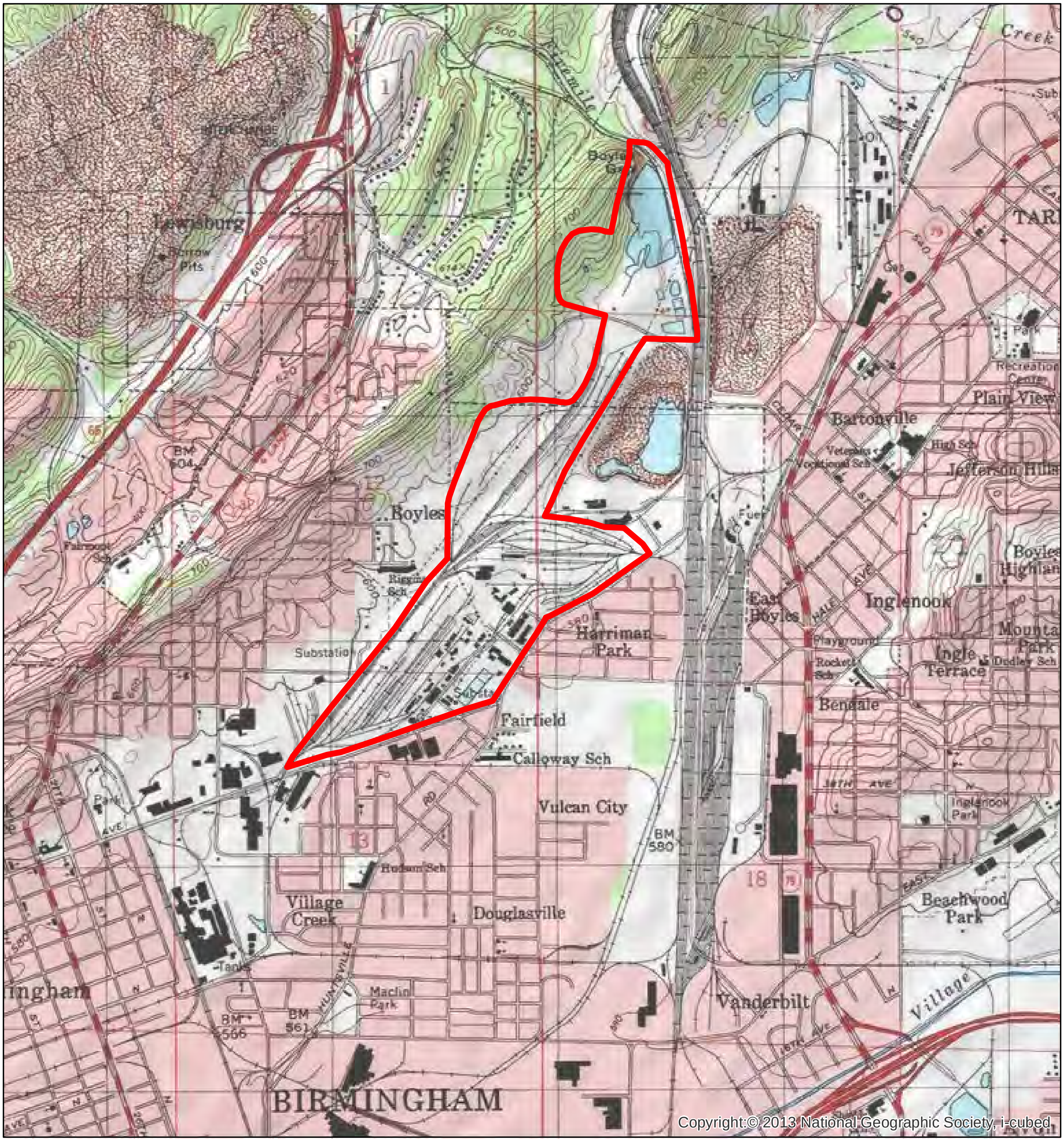
	Industrial/Commercial Worker		Construction Worker	
Chemical	**ELCR**	**HQ**	**ELCR**	**HQ**
Benz(a)anthracene	2.6E-07	NA	1.7E-07	NA
Benzo(a)pyrene	2.4E-06	NA	4.1E-06	NA
Benzo(b)fluoranthene	4.1E-07	NA	3.6E-07	NA
Benzo(k)fluoranthene	1.3E-08	NA	1.2E-08	NA
Chrysene	3.6E-09	NA	2.2E-09	NA
Dibenz(a,h)anthracene	7.0E-07	NA	1.0E-06	NA
Indeno(1,2,3-cd)pyrene	1.7E-07	NA	3.3E-07	NA
Naphthalene	--	--	6.6E-08	5.5E-02
Arsenic	3.6E-06	1.8E-02	8.7E-07	1.3E-01
Chromium	2.1E-06	3.8E-03	8.3E-07	3.9E-02
Mercury	--	--	NA	3.4E-07
Totals	9.7E-06	2.2E-02	7.7E-06	2.3E-01

ELCR = Excess Lifetime Cancer Risk
HQ = Hazard Quotient
na = not applicable; toxicity factors are not available for these chemicals
-- = chemical not a COPC for that receptor

Table 3.11
Preliminary Cleanup Standards for SMA 5 Soil
all units mg/Kg
ERP Coke Facility, Birmingham, AL

	Target Risk Level			Target Hazard Quotient		
Chemical of Concern	**1.0E-04**	**1.0E-05**	**1.0E-06**	**3.0**	**1.0**	**0.1**
Industrial/Commercial Workers						
Benzo(a)pyrene	21	2.1	0.21	na	na	na
Arsenic	159	16	1.6	767	256	26
Chromium	568	57	5.7	9,187	3,062	306
Construction Workers						
Benzo(a)pyrene	235	24	2.4	na	na	na
Dibenzo(a,h)anthracene	236	24	2.4	na	na	na

na = not applicable; toxicity parameters are unavailable



Legend

Facility Boundary

DATA SOURCES:
- Topographic Map: North Birmingham, AL, 7.5 Minutes Quadrangle, 1997

0 1,000 2,000 4,000 Feet

N

N:\GIS\E1127096_Walter_Coke_ALT_project\mxd\Sept2014\E1147150_Fig1-1_SiteLocation_090814_102.mxd

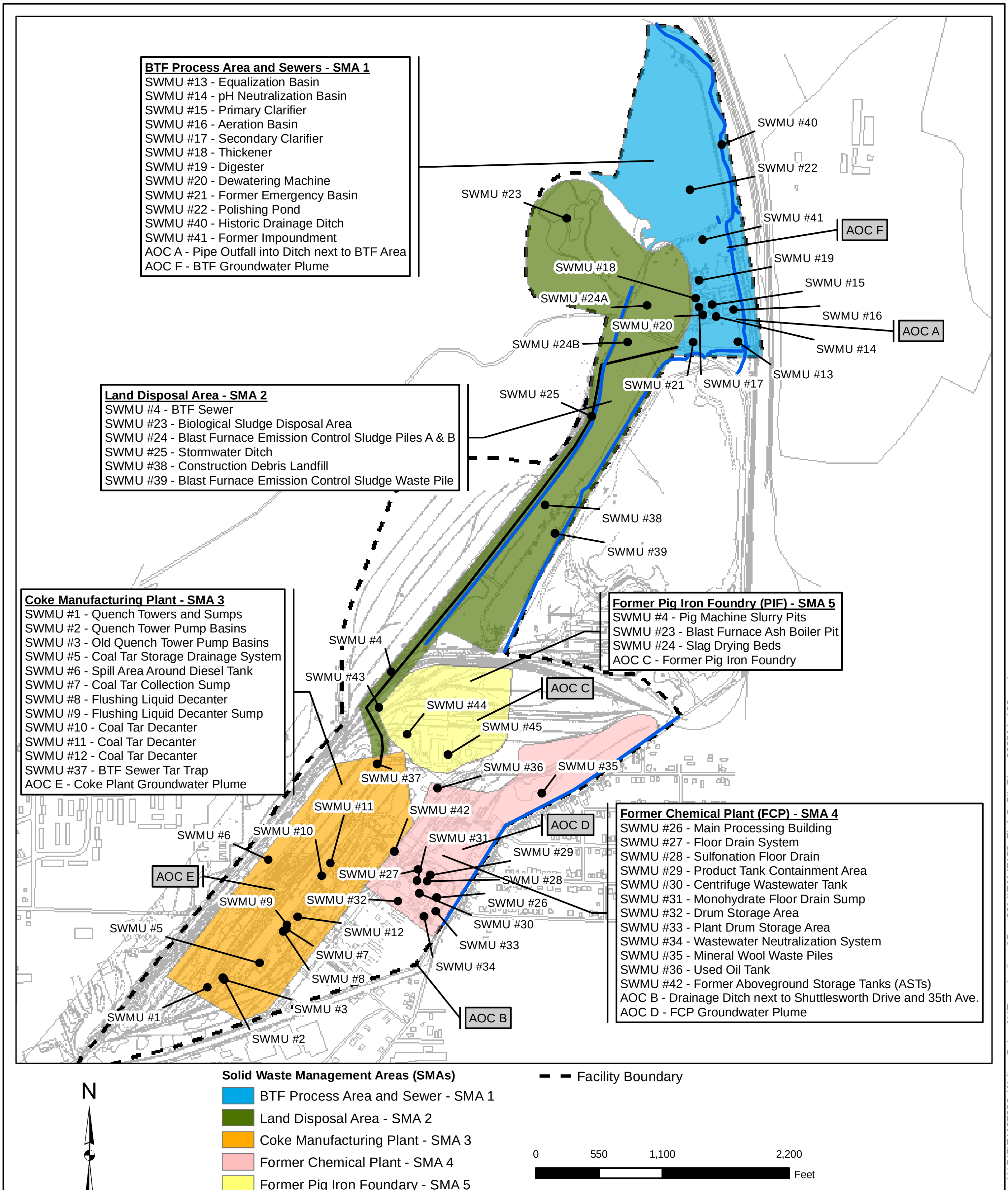
Project No.	E1147106
Drawn By:	JDF
Reviewed By:	TWR
Date:	September 2014

Terracon
110 12th Street North Birmingham, Al 35203
PH. (205) 942 1289 terracon.com

Facility Location Map

ERP COMPLIANT COKE, LLC
3500 35th AVENUE NORTH
BIRMINGHAM, ALABAMA

Figure 1-1



NOTES:
- AOC = Area of Concern
- SWMU = Solid Waste Management Unit
- Management Area Boundaries Are Approximations

Project No.	E1147106
Drawn By:	JDF
Reviewed By:	TWR
Date:	September 2014

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110 12th Street North Birmingham, Al 35203
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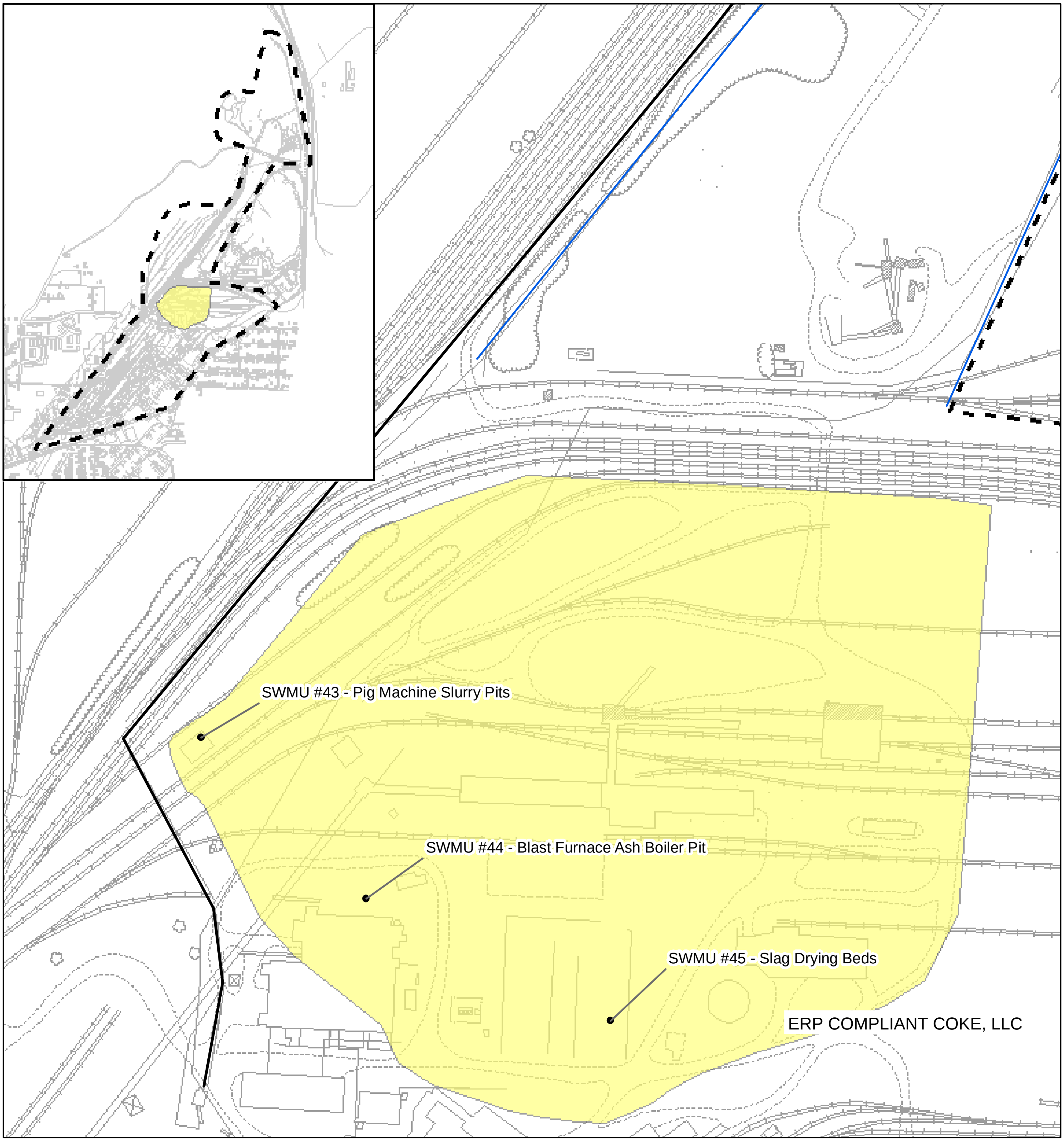
Site Map

ERP COMPLIANT COKE, LLC
3500 35th AVENUE NORTH
BIRMINGHAM, ALABAMA

Figure

1-2



N

SMA 5 - Former Pig Iron Foundary

Facility Boundary

Base

0 100 200 400 Feet

N:\GIS\E1127096_Walter_Coke_ALT_project\mxd\Sept2014\E1147150_Fig1-3_CokePlant_090814_102.mxd

NOTES:
- SMA = Soil Management Area
- SWMU = Solid Waste Management Unit
- Management Area Boundaries Are Approximations

Project No.	E1147106
Drawn By:	JDF
Reviewed By:	TWR
Date: September 2014	

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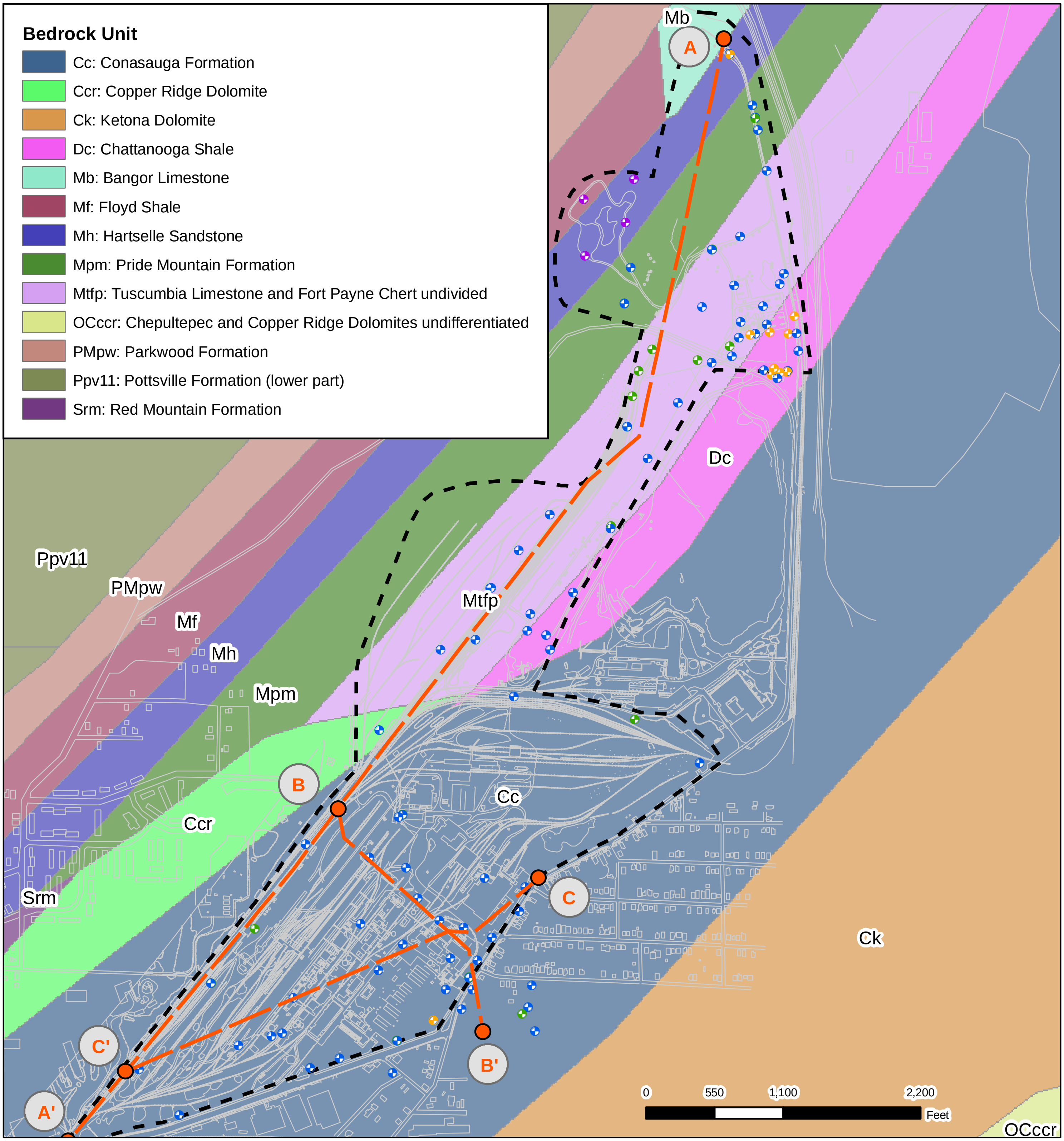
Former Pig Iron Foundary

ERP COMPLIANT COKE, LLC
3500 35th AVENUE NORTH
BIRMINGHAM, ALABAMA

Figure

1-3



N

- Shallow Bedrock Monitoring Well
- Deep Bedrock Monitoring Well
- Residuum or Mixed Monitoring Well
- Non-Conasauga Monitoring Well
- Base
- Facility Boundary
- Geologic Cross Section Location

N:\GIS\E1127096_Walter_Coke_ALT_project\mxd\Sept2014\E1147150_Fig1-4_XSecLoc_090814_102.mxd

NOTES:
- AOC = Area of Concern
- SWMU = Solid Waste Management Unit
- Management Area Boundaries Are Approximations

Project No.	E1147106
Drawn By:	JDF
Reviewed By:	TWR
Date:	September 2014

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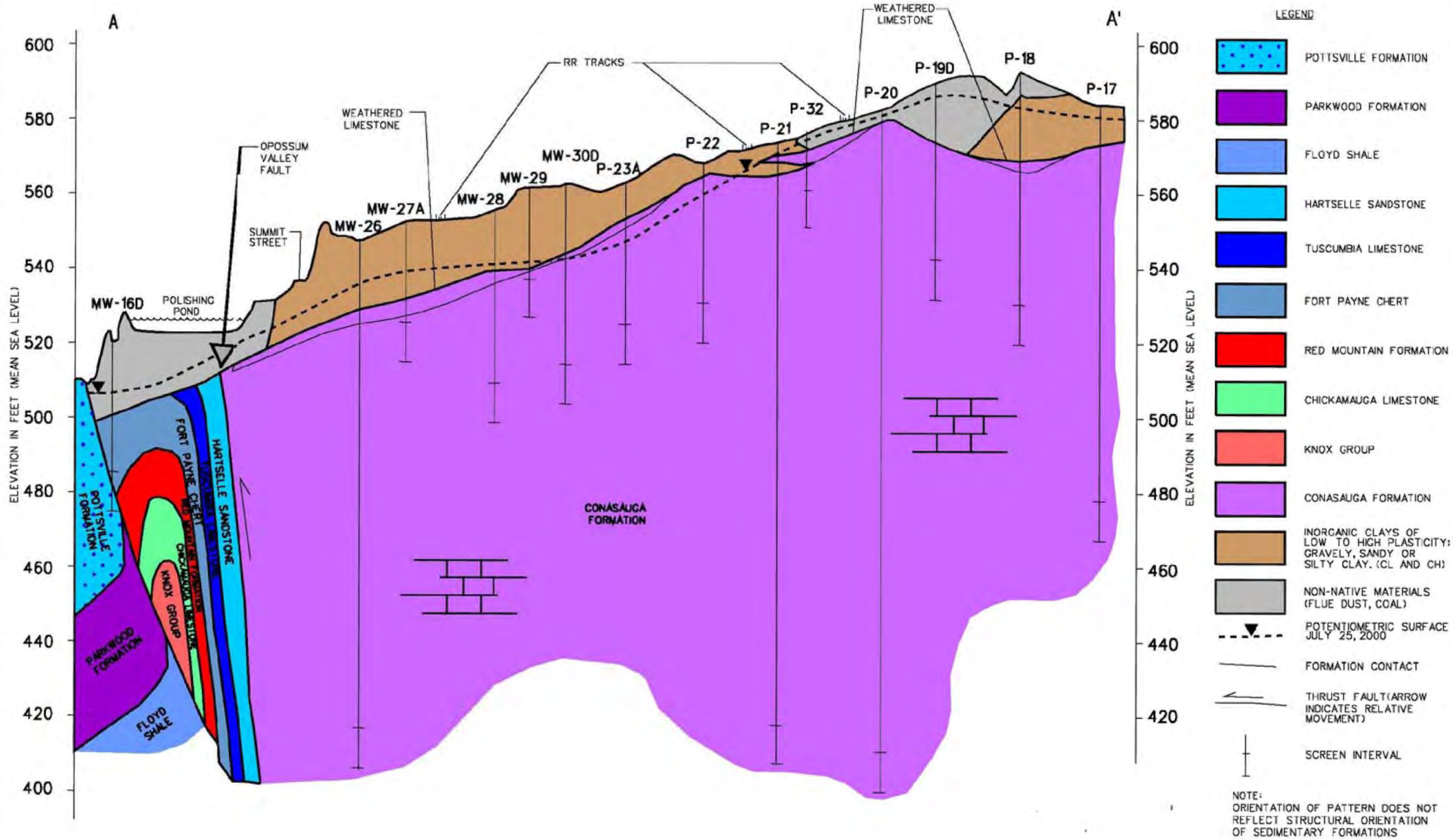
Geologic Cross-Section Location Map

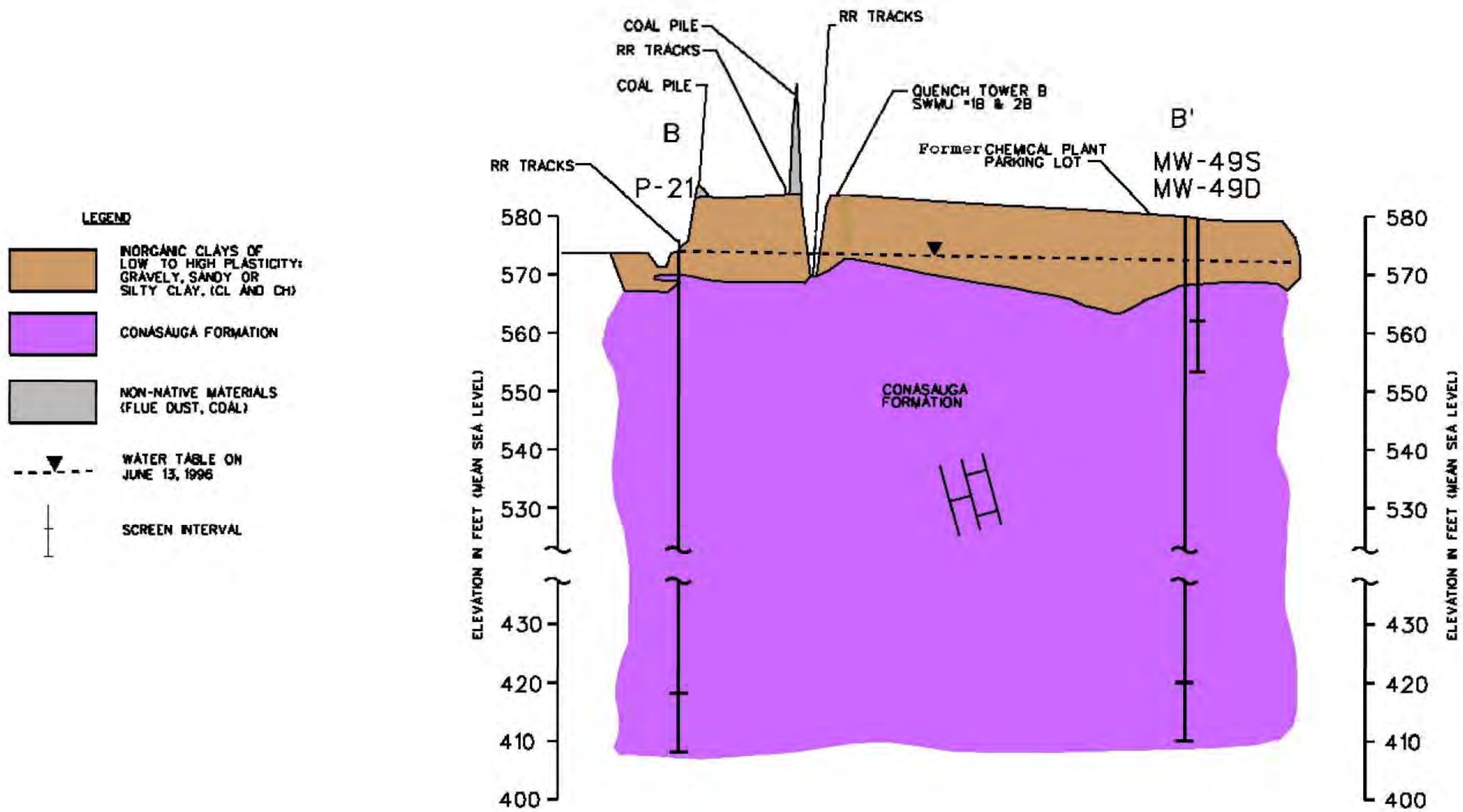
ERP COMPLIANT COKE, LLC
3500 35th AVENUE NORTH
BIRMINGHAM, ALABAMA

Figure
1-4



Project Manager: TWR	Project No. E1147106	Terracon	GEOLOGIC CROSS SECTION A-A'
Drawn by: MRF	Scale: NA.	110 12th Street North, Birmingham, Al 35203	ERP COMPLIANT COKE, LLC
Checked by: TWR	File Name: X-Section A-A'	PH. (205) 942 1289	3500 35th Avenue North
Approved by: TWR	Date: September 2014	terracon.com	Birmingham, Alabama

Figure 1-5



Project Manager: TWR	Project No. E1147106
Drawn by: MRF	Scale: NA.
Checked by: TWR	File Name: X-Section B-B'
Approved by: TWR	Date: September 2014

Terracon
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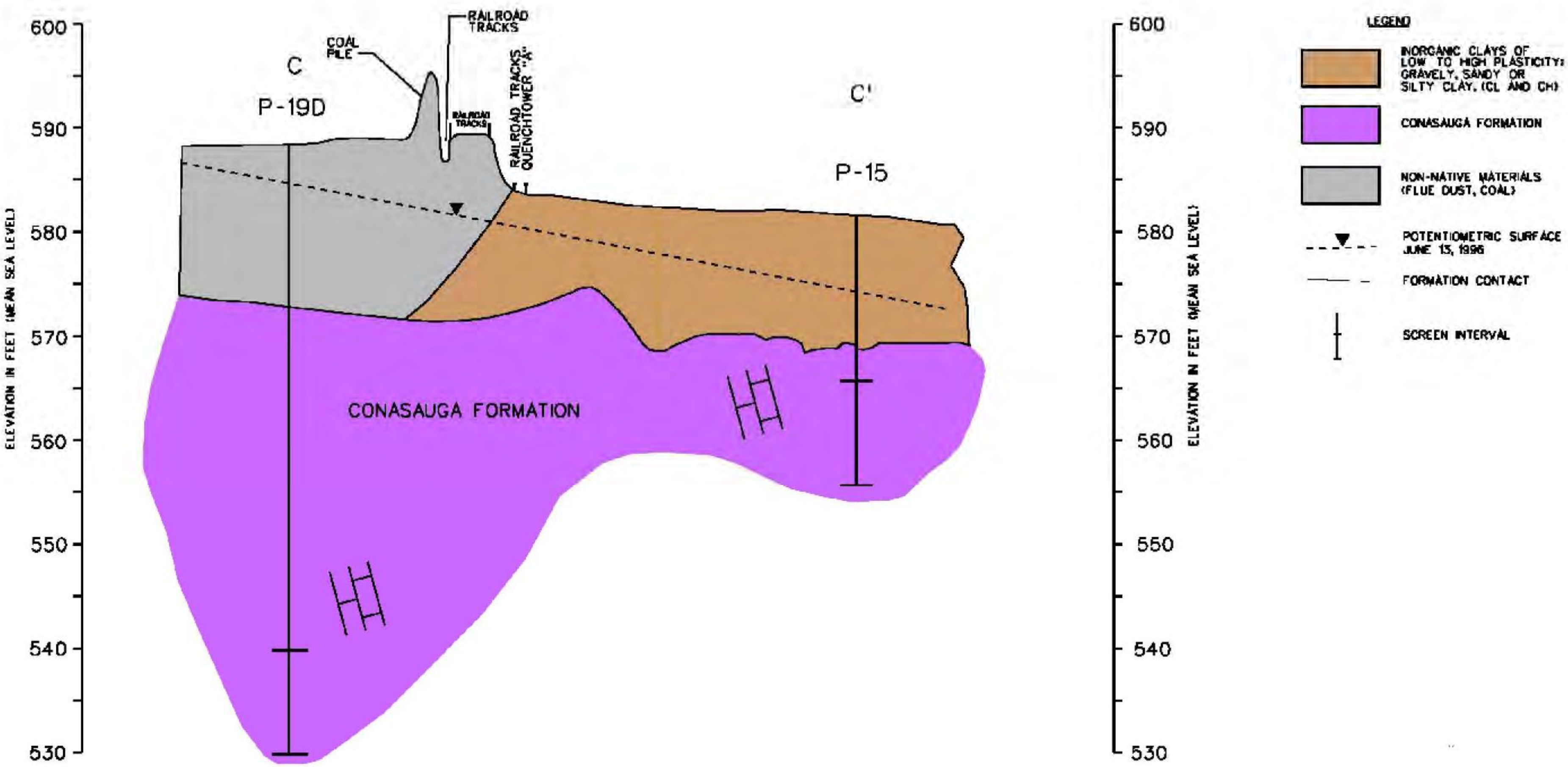
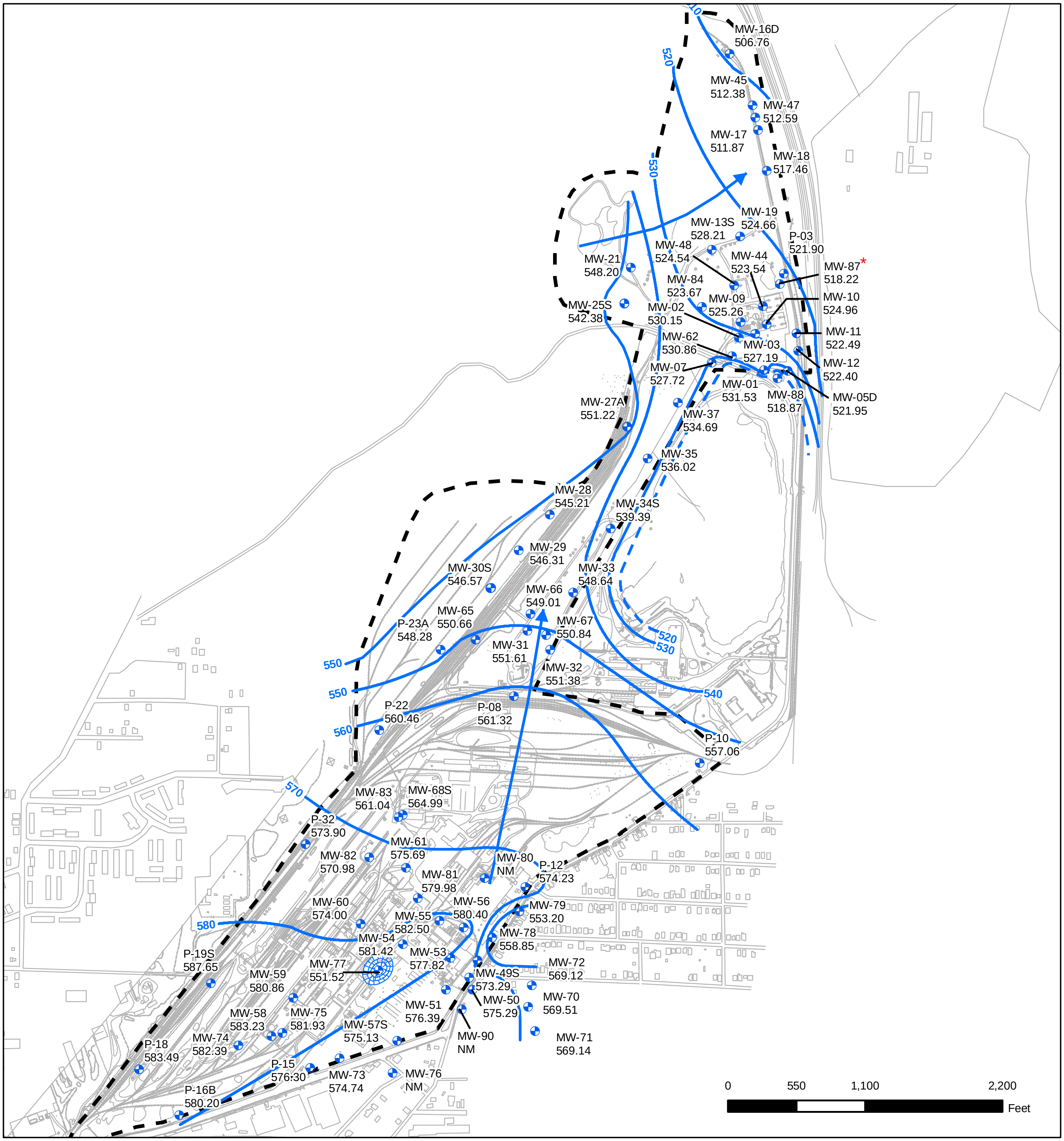
GEOLOGIC CROSS SECTION B-B'

ERP COMPLIANT COKE, LLC
3500 35th Avenue North
Birmingham, AL 35207

Figure
1-6



Project Manager: TWR	Project No. E1147106	Terracon	GEOLOGIC CROSS SECTION C-C'	Figure
Drawn by: MRF	Scale: NA		ERP COMPLIANT COKE, LLC	1-7
Checked by: TWR	File Name: X-Section C-C'	110 12th Street North Birmingham, Al 35203	3500 35th Avenue North	
Approved by: TWR	Date: September 2014	PH. (205) 942 1289 terracon.com	Birmingham, AL 35207	



N

Shallow Bedrock Monitoring Well

580 Shallow Bedrock Contour

Shallow Bedrock Contour (Inferred)

Depression

576.39 Shallow Bedrock Groundwater Elevation (ft msl)

Base

Facility Boundary

* Well data not used for contouring

N:\GIS\E1127096_Walter_Coke_ALIT_project\mxd\Sept2014\E1147150_Fig1-8_SBpotentio_090914_102.mxd

NOTES:
- Groundwater elevations measured on April 28th & 29th, 2008
- ft msl = feet mean sea level
- NM = not measured

Project No.	E1147106
Drawn By:	JDF
Reviewed By:	TWR
Date: September 2014	

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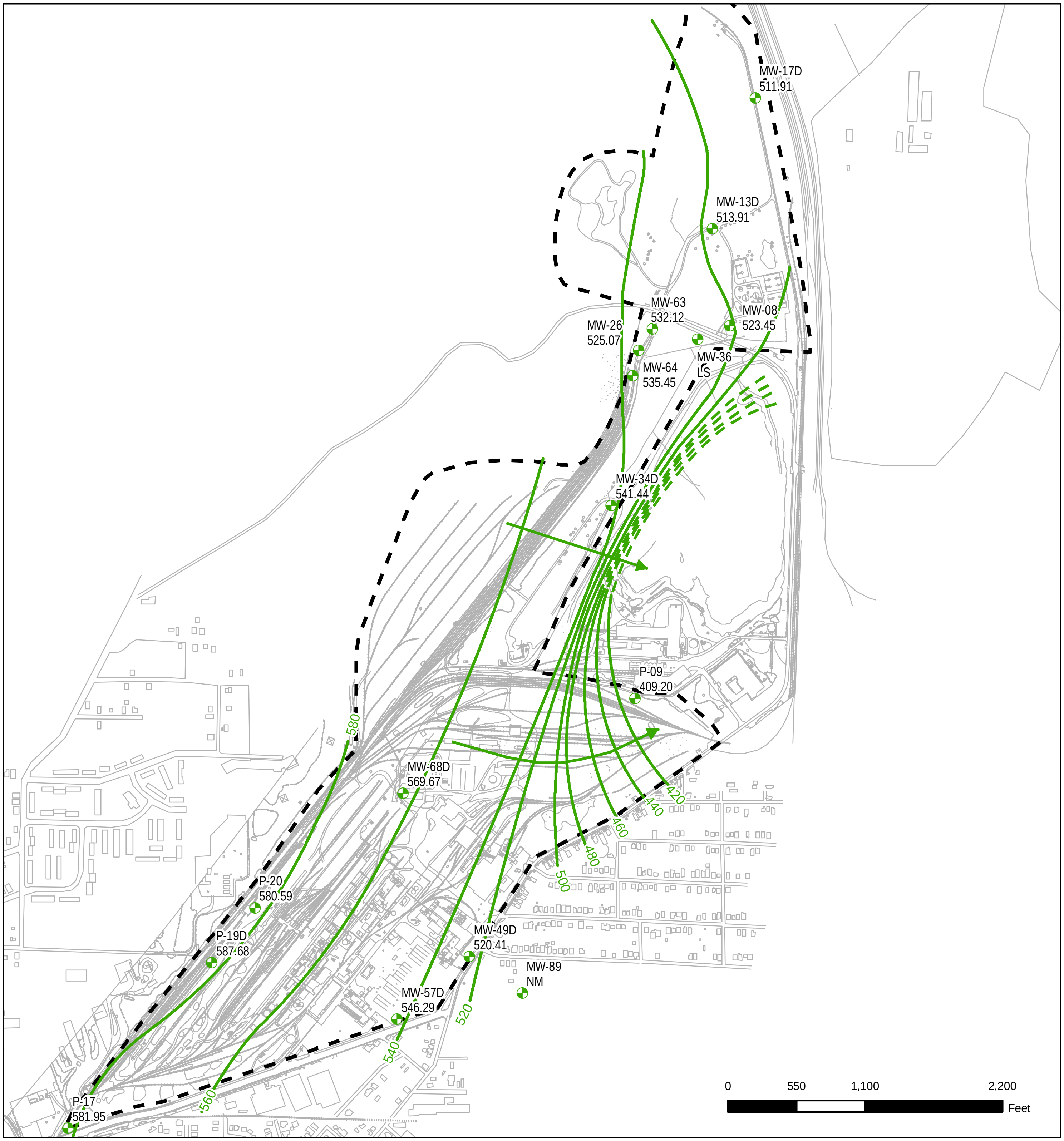
Shallow Bedrock Potentiometric Surface Map

ERP COMPLIANT COKE, LLC
3500 35th AVENUE NORTH
BIRMINGHAM, ALABAMA

Figure

1-8



N

Deep Bedrock Monitoring Well

540 Deep Bedrock Contour

Deep Bedrock Contour (Inferred)

546.29 Deep Bedrock Groundwater Elevation (ft msl)

Base

Facility Boundary

N:\GIS\E1127096_Walter_Coke_ALT_project\mxd\Sept2014\E1147150_Fig1-9_DBpotentio_090914_102.mxd

NOTES:

Project No.	E1147106
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Reviewed By:	TWR
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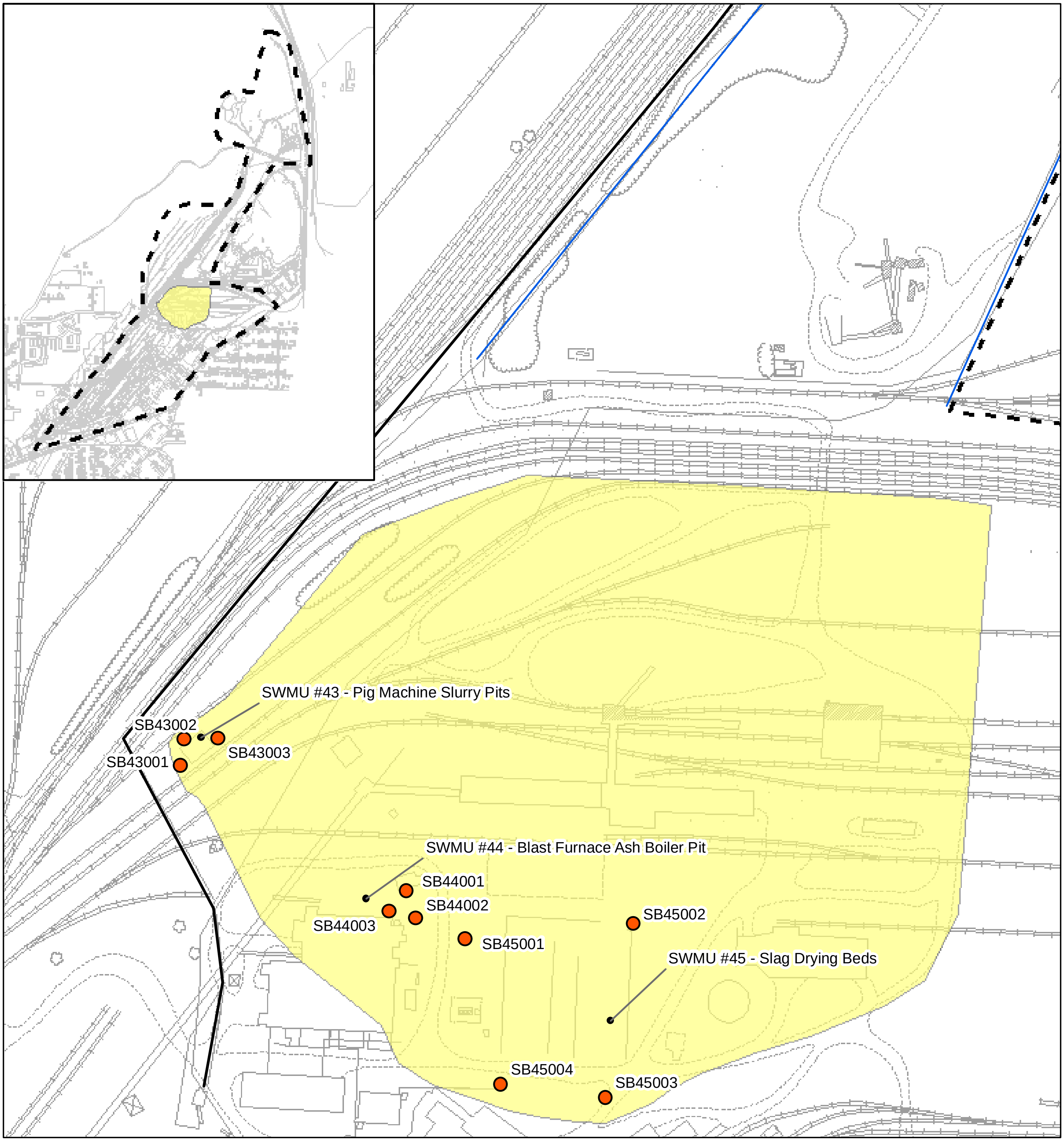
Deep Bedrock Potentiometric Surface Map

ERP COMPLIANT COKE, LLC
3500 35th AVENUE NORTH
BIRMINGHAM, ALABAMA

Figure

1-9



SMA 5 - Former Pig Iron Foundary

Facility Boundary

Base

Soil Boring Location

N

0 100 200 400 Feet

N:\GIS\E1127096_Walter_Coke_ALT_project\mxd\Sept2014\E1147150_Fig2-1_PIFsbs_090914_102.mxd

NOTES:
- SMA = Soil Management Area
- SWMU = Solid Waste Management Unit
- Management Area Boundaries Are Approximations

Project No.	E1147106
Drawn By:	JDF
Reviewed By:	TWR
Date: September 2014	

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Former Pig Iron Foundary
Soil Boring Locations

ERP COMPLIANT COKE, LLC
3500 35th AVENUE NORTH
BIRMINGHAM, ALABAMA

Figure

2-1

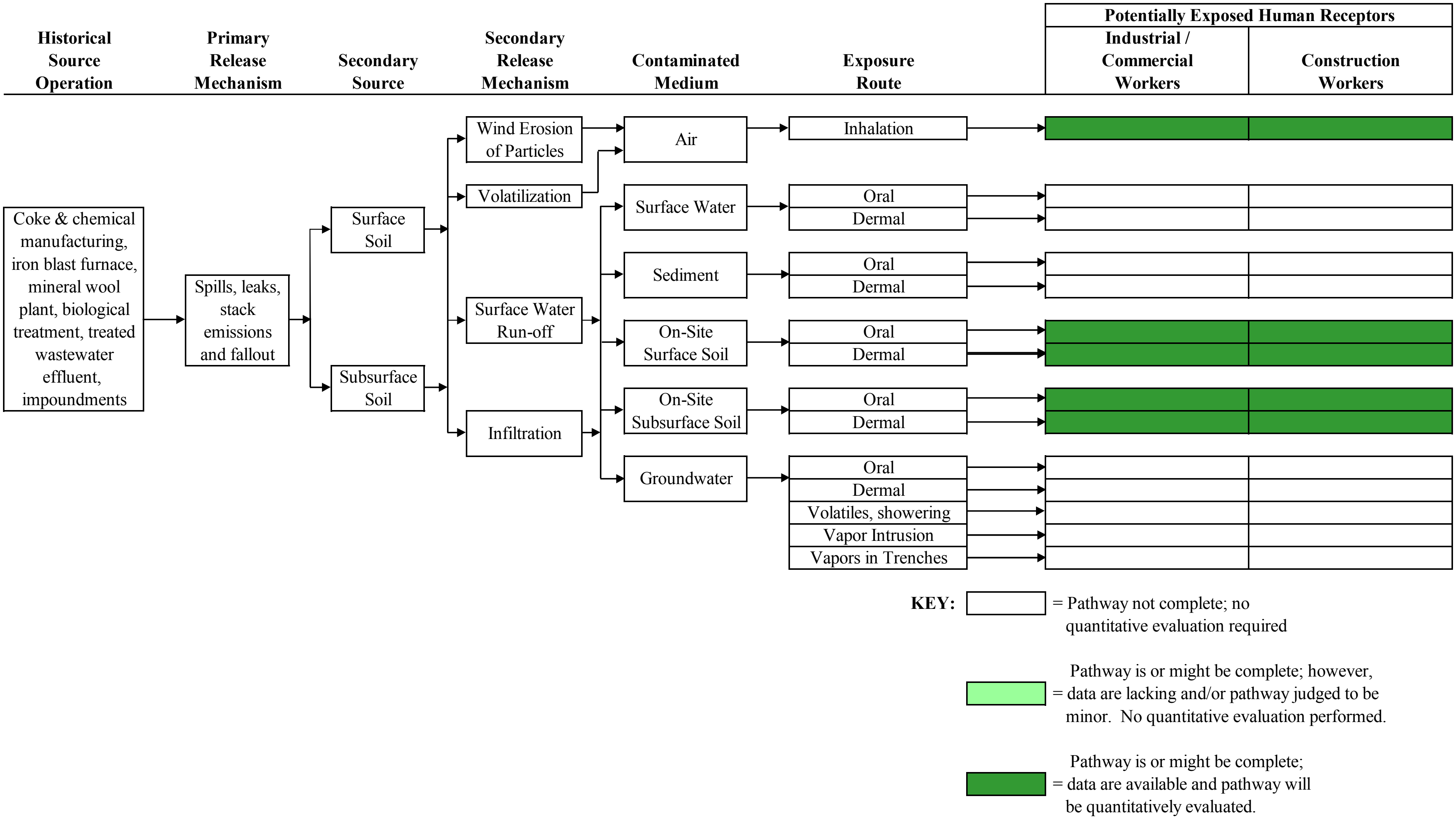
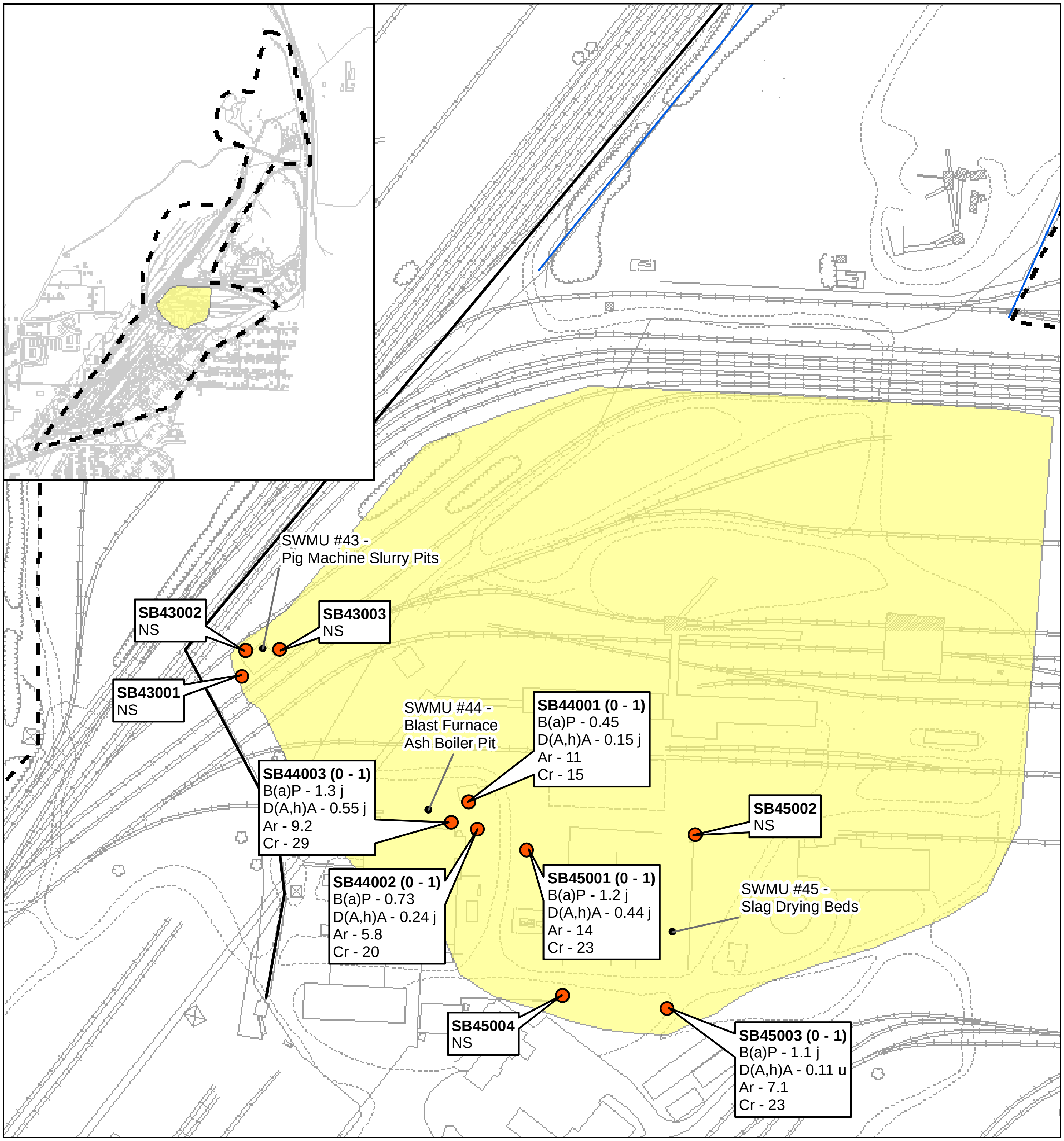


Figure 3.1. SMA 5. Human Health Risk Assessment, Conceptual Site Model. ERP Coke Facility, Birmingham, AL



Soil Boring Location

SMA 5 - Former Pig Iron Foundary

Facility Boundary

Base

N

0 100 200 400 Feet

NOTES:
- Samples collected on 6/16/2014
- All concentrations in mg/Kg
- B(a)P = Benzo(a)pyrene
- D(a,h)A = Dibenz(a,h)anthracene
- As = Arsenic
- Cr = Chromium
- NS = not sampled
- SMA = Soil Management Area
- SWMU = Solid Waste Management Unit

Project No.	E1147106
Drawn By:	JDF
Reviewed By:	TWR
Date: September 2015	

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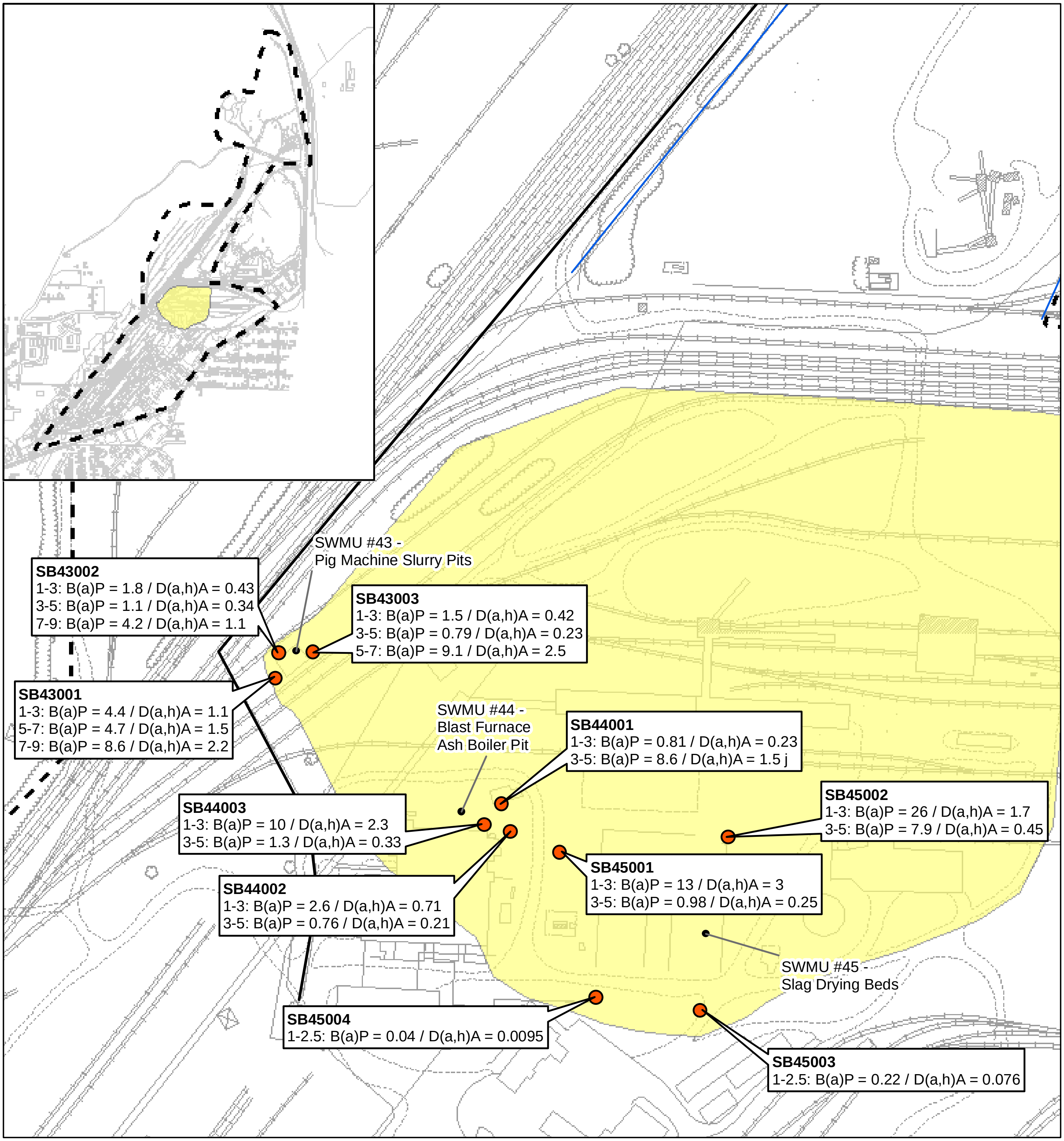
Concentrations of Select COCs in Surface Soil (0 - 1 ft)

ERP COMPLIANT COKE, LLC
3500 35th AVENUE NORTH
BIRMINGHAM, ALABAMA

Figure

3-2



- Soil Boring Location
- SMA 5 - Former Pig Iron Foundary
- Facility Boundary
- Base

N

0 100 200 400 Feet

NOTES:
- Samples collected on 6/16 & 6/17/2014
- All concentrations in mg/Kg
- B(a)P = Benzo(a)pyrene
- D(a,h)A = Dibenz(a,h)anthracene
- SMA = Soil Management Area
- SWMU = Solid Waste Management Unit

Project No.	E1147106
Drawn By:	JDF
Reviewed By:	TWR
Date:	September 2015

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Concentrations of Select COCs in Subsurface Soil (1 - 9 ft)

ERP COMPLIANT COKE, LLC
3500 35th AVENUE NORTH
BIRMINGHAM, ALABAMA

Figure
3-3

APPENDIX A

SURFICIAL AND SUBSURFACE SOIL ANALYTICAL DATA FOR SAMPLES COLLECTED IN SMA 5

Table 1
SMA-5 - Surficial Soil Analytical Results
ERP Coke Facility, Birmingham, Alabama

Boring Number Depth (feet) Date Sample Collected	SB44001 0-1 6/16/2014		SB44002 0-1 6/16/2014		SB44003 0-1 6/16/2014		SB45001 0-1 6/16/2014		SB45003 0-1 6/16/2014	
1,1,1-Trichloroethane	0.00065	u	0.00055	u	0.00054	u	0.00063	u	0.00051	u
1,1,2,2-Tetrachloroethane	0.00076	u	0.00064	u	0.00063	u	0.00074	u	0.0006	u
1,1,2-Trichloroethane	0.0011	u	0.00092	u	0.00091	u	0.0011	u	0.00087	u
1,1,2-Trichlorotrifluoroethane	0.00056	u	0.00047	u	0.00046	u	0.00055	u	0.00045	u
1,1-Dichloroethane	0.00026	u	0.00022	u	0.00022	u	0.00026	u	0.00021	u
1,1-Dichloroethene	0.00073	u	0.00062	u	0.00061	u	0.00072	u	0.00058	u
1,2,3-Trichlorobenzene	0.00093	u	0.00079	u	0.00077	u	0.00091	u	0.00074	u
1,2,4-Trichlorobenzene	0.00091	u	0.00077	u	0.00075	u	0.00089	u	0.00072	u
1,2-Dibromo-3-chloropropane	0.00075	u	0.00063	u	0.00062	u	0.00073	u	0.00059	u
1,2-Dibromoethane	0.00065	u	0.00055	u	0.00054	u	0.00063	u	0.00051	u
1,2-Dichlorobenzene	0.00056	u	0.00047	u	0.00046	u	0.00055	u	0.00045	u
1,2-Dichloroethane	0.00087	u	0.00073	u	0.00072	u	0.00085	u	0.00069	u
1,2-Dichloropropane	0.00068	u	0.00058	u	0.00057	u	0.00067	u	0.00054	u
1,3-Dichlorobenzene	0.0006	u	0.0005	u	0.0005	u	0.00058	u	0.00048	u
1,4-Dichlorobenzene	0.00097	u	0.00082	u	0.0008	u	0.00095	u	0.00077	u
1,4-Dioxane	0.07	u	0.059	u	0.058	u	0.068	u	0.056	u
2-Butanone	0.0023	u	0.0019	u	0.0019	u	0.0022	u	0.0018	u
2-Hexanone	0.0061	u	0.0051	u	0.005	u	0.0059	u	0.0048	u
4-Methyl-2-pentanone	0.0054	u	0.0046	u	0.0045	u	0.0053	u	0.0043	u
Acetone	0.0067	u	0.0056	u	0.0056	u	0.0065	u	0.0053	u
Benzene	0.00058	u	0.00049	u	0.00048	u	0.00057	u	0.00047	u
Bromodichloromethane	0.00027	u	0.00023	u	0.00023	u	0.00027	u	0.00022	u
Bromoform	0.00029	u	0.00024	u	0.00024	u	0.00028	u	0.00023	u
Bromomethane	0.00062	u	0.00052	u	0.00052	u	0.00061	u	0.0005	u
Carbon disulfide	0.00052	u	0.00044	u	0.00043	u	0.00051	u	0.00042	u
Carbon tetrachloride	0.00078	u	0.00066	u	0.00065	u	0.00077	u	0.00062	u
Chlorobenzene	0.00067	u	0.00057	u	0.00056	u	0.00066	u	0.00053	u
Chlorobromomethane	0.00037	u	0.00031	u	0.00031	u	0.00036	u	0.0003	u
Chloroethane	0.0011	u	0.00093	u	0.00092	u	0.0011	u	0.00088	u
Chloroform	0.00036	u	0.0003	u	0.0003	u	0.00035	u	0.00029	u
Chloromethane	0.00096	u	0.00081	u	0.00079	u	0.00094	u	0.00076	u
cis-1,2-Dichloroethene	0.0007	u	0.00059	u	0.00058	u	0.00068	u	0.00055	u
cis-1,3-Dichloropropene	0.0016	u	0.0014	u	0.0013	u	0.0016	u	0.0013	u
Cyclohexane	0.0005	u	0.00042	u	0.00041	u	0.00049	u	0.0004	u
Cyclohexane, Methyl-	0.00052	u	0.00044	u	0.00043	u	0.00051	u	0.00042	u
Dibromochloromethane	0.00071	u	0.0006	u	0.00059	u	0.00069	u	0.00056	u
Dichlorodifluoromethane	0.00065	u	0.00055	u	0.00054	u	0.00063	u	0.00051	u
Ethylbenzene	0.00083	u	0.0007	u	0.00069	u	0.00082	u	0.00066	u
Isopropylbenzene	0.00073	u	0.00062	u	0.00061	u	0.00072	u	0.00058	u
Methyl acetate	0.0034	u	0.0029	u	0.0028	u	0.0033	u	0.0027	u
Methyl tert-butyl ether	0.00042	u	0.00036	u	0.00035	u	0.00041	u	0.00034	u
Methylene chloride	0.002	u	0.0017	u	0.0022	j	0.0019	u	0.0016	u
m-Xylene & p-Xylene	0.0013	u	0.0011	u	0.0011	u	0.0013	u	0.001	u

Table 1
SMA-5 - Surficial Soil Analytical Results
ERP Coke Facility, Birmingham, Alabama

Boring Number Depth (feet) Date Sample Collected	**SB44001** **0-1** **6/16/2014**		**SB44002** **0-1** **6/16/2014**		**SB44003** **0-1** **6/16/2014**		**SB45001** **0-1** **6/16/2014**		**SB45003** **0-1** **6/16/2014**	
o-Xylene	0.00076	u	0.00099	j	0.00063	u	0.00074	u	0.0006	u
Styrene	0.00078	u	0.00066	u	0.00065	u	0.00077	u	0.00062	u
Tetrachloroethene	0.00073	u	0.00062	u	0.00061	u	0.00072	u	0.00058	u
Toluene	0.00086	u	0.00072	u	0.00071	u	0.00084	u	0.00068	u
trans-1,2-Dichloroethene	0.00048	u	0.00041	u	0.0004	u	0.00047	u	0.00039	u
trans-1,3-Dichloropropene	0.00083	u	0.0007	u	0.00069	u	0.00082	u	0.00066	u
Trichloroethene	0.00029	u	0.00024	u	0.00024	u	0.00028	u	0.00023	u
Trichlorofluoromethane	0.0013	u	0.0011	u	0.0011	u	0.0013	u	0.001	u
Vinylchloride	0.0017	u	0.0014	u	0.0014	u	0.0016	u	0.0013	u
1,2,4-Trichlorobenzene	0.03	u	0.03	u	0.15	u	0.15	u	0.16	u
1,2-Dichlorobenzene	0.024	u	0.023	u	0.12	u	0.12	u	0.12	u
1,3-Dichlorobenzene	0.013	u	0.013	u	0.064	u	0.064	u	0.068	u
1,4-Dichlorobenzene	0.015	u	0.014	u	0.073	u	0.073	u	0.077	u
1,4-Dioxane	0.071	u	0.07	u	0.35	u	0.35	u	0.37	u
2,4,5-Trichlorophenol	0.011	u	0.011	u	0.053	u	0.053	u	0.057	u
2,4,6-Trichlorophenol	0.011	u	0.011	u	0.053	u	0.053	u	0.057	u
2,4-Dichlorophenol	0.011	u	0.011	u	0.053	u	0.053	u	0.057	u
2,4-Dimethylphenol	0.071	u	0.07	u	0.35	u	0.35	u	0.37	u
2,4-Dinitrophenol	0.36	u	0.35	u	1.8	u	1.8	u	1.9	u
2,4-Dinitrotoluene	0.071	u	0.07	u	0.35	u	0.35	u	0.37	u
2-Chloronaphthalene	0.011	u	0.011	u	0.053	u	0.053	u	0.057	u
2-Chlorophenol	0.023	u	0.022	u	0.11	u	0.11	u	0.12	u
2-Methylnaphthalene	0.033	j	0.11	j	0.41	j	0.2	j	0.48	j
2-Methylphenol	0.014	u	0.014	u	0.069	u	0.069	u	0.074	u
2-Nitroaniline	0.054	u	0.053	u	0.27	u	0.27	u	0.28	u
2-Nitrophenol	0.011	u	0.011	u	0.053	u	0.053	u	0.057	u
3 & 4 Methylphenol	0.036	u	0.035	u	0.18	u	0.18	u	0.19	u
3,3'-Dichlorobenzidine	0.097	u	0.095	u	0.48	u	0.48	u	0.51	u
3-Nitroaniline	0.079	u	0.077	u	0.39	u	0.39	u	0.41	u
4,6-Dinitro-2-methylphenol	0.36	u	0.35	u	1.8	u	1.8	u	1.9	u
4-Bromophenyl-phenylether	0.021	u	0.02	u	0.1	u	0.1	u	0.11	u
4-Chloro-3-methylphenol	0.071	u	0.07	u	0.35	u	0.35	u	0.37	u
4-Chloroaniline	0.089	u	0.087	u	0.44	u	0.44	u	0.46	u
4-Chlorophenyl-phenylether	0.023	u	0.022	u	0.11	u	0.11	u	0.12	u
4-Nitroaniline	0.078	u	0.077	u	0.39	u	0.39	u	0.41	u
4-Nitrophenol	0.11	u	0.1	u	0.52	u	0.52	u	0.55	u
Acenaphthene	0.026	j	0.036	j	0.055	u	0.068	j	0.093	j
Acenaphthylene	0.11	j	0.083	j	0.12	j	0.15	j	0.11	j
Acetophenone	0.022	u	0.021	u	0.11	u	0.11	u	0.11	u
Anthracene	0.077	j	0.12	j	0.25	j	0.26	j	0.29	j
Benz(a)anthracene	0.32	j	**0.65**		1	j	1.2	j	0.78	j
Benzo(a)pyrene	**0.45**		**0.73**		1.3	j	1.2	j	1.1	j
Benzo(b)fluoranthene	**0.67**		**1.1**		**1.9**		**1.9**		1.8	j

Table 1
SMA-5 - Surficial Soil Analytical Results
ERP Coke Facility, Birmingham, Alabama

Boring Number	**SB44001**		**SB44002**		**SB44003**		**SB45001**		**SB45003**	
Depth (feet)	**0-1**		**0-1**		**0-1**		**0-1**		**0-1**	
Date Sample Collected	**6/16/2014**		**6/16/2014**		**6/16/2014**		**6/16/2014**		**6/16/2014**	
Benzo(g,h,i)perylene	**0.41**		**0.64**		1.1	j	0.98	j	1	j
Benzo(k)fluoranthene	0.24	j	**0.42**		0.63	j	0.77	j	0.67	j
Benzyl alcohol	0.011	u	0.011	u	0.053	u	0.053	u	0.057	u
bis(2-Chloroethoxy)methane	0.025	u	0.024	u	0.12	u	0.12	u	0.13	u
bis(2-Chloroethyl)ether	0.018	u	0.018	u	0.089	u	0.089	u	0.094	u
bis(2-Chloroisopropyl)ether	0.025	u	0.024	u	0.12	u	0.12	u	0.13	u
bis(2-Ethylhexyl)phthalate	0.097	j	0.12	j	0.64	j	0.25	u	1.1	j
Butyl benzyl phthalate	0.047	u	0.046	u	0.23	u	0.23	u	0.24	u
Carbazole	0.039	u	0.052	j	0.19	u	0.19	u	0.2	u
Chrysene	**0.39**		**0.89**		1.6	j	1.4	j	1.4	j
Dibenz(a,h)anthracene	0.15	j	0.24	j	0.55	j	0.44	j	0.11	u
Dibenzofuran	0.022	j	0.056	j	0.17	j	0.13	j	0.2	j
Diethylphthalate	0.028	u	0.028	u	0.14	u	0.14	u	0.15	u
Dimethyl phthalate	0.05	j	0.031	j	0.12	u	0.12	u	0.13	u
Di-N-Butyl phthalate	0.031	u	0.031	u	0.16	u	0.15	u	0.16	u
Di-N-Octyl phthalate	0.016	u	0.015	u	0.077	u	0.63	j	0.082	u
Fluoranthene	**0.44**		**0.73**		1.2	j	1.6	j	1.3	j
Fluorene	0.019	u	0.041	j	0.096	u	0.096	u	0.18	j
Hexachlorobenzene	0.031	u	0.031	u	0.16	u	0.15	u	0.16	u
Hexachlorobutadiene	0.011	u	0.011	u	0.053	u	0.053	u	0.057	u
Hexachlorocyclopentadiene	0.054	u	0.053	u	0.27	u	0.27	u	0.28	u
Hexachloroethane	0.023	u	0.023	u	0.11	u	0.11	u	0.12	u
Indeno(1,2,3-cd)pyrene	**0.45**		**0.67**		1.1	j	1.1	j	1.1	j
Isophorone	0.018	u	0.018	u	0.091	u	0.091	u	0.096	u
Naphthalene	0.093	j	0.18	j	0.52	j	0.29	j	0.6	j
Nitrobenzene	0.024	u	0.023	u	0.12	u	0.12	u	0.12	u
N-Nitroso-di-N-propylamine	0.034	u	0.033	u	0.17	u	0.17	u	0.18	u
N-Nitrosodiphenylamine	0.023	u	0.022	u	0.11	u	0.11	u	0.12	u
Pentachlorophenol	0.36	u	0.35	u	1.8	u	1.8	u	1.9	u
Phenanthrene	0.2	j	**0.43**		1	j	1	j	1.2	j
Phenol	0.019	u	0.019	u	0.096	u	0.096	u	0.1	u
Pyrene	**0.43**		**0.69**		1.2	j	1.4	j	1.3	j
2-Methylnaphthalene	**0.11**		**0.35**		**0.58**		**0.29**		**0.56**	
Acenaphthene	**0.027**		**0.045**		**0.042**		**0.059**		**0.048**	
Acenaphthylene	**0.1**		**0.12**		**0.11**		**0.27**		**0.091**	
Anthracene	**0.088**		**0.24**		**0.27**		**0.33**		**0.29**	
Benz(a)anthracene	**0.26**		**1.1**		**0.89**		**1**		**0.57**	
Benzo(a)pyrene	**0.37**		**1.1**		**0.93**		**0.88**		**0.57**	
Benzo(b)fluoranthene	**0.59**		**1.8**		**1.4**		**1.6**		**1.1**	
Benzo(g,h,i)perylene	**0.34**		**0.83**		**0.77**		**0.61**		**0.46**	
Benzo(k)fluoranthene	**0.22**		**0.64**		**0.39**		**0.48**		**0.33**	
Chrysene	**0.34**		**1.5**		**1.5**		**1.4**		**1.3**	
Dibenz(a,h)anthracene	**0.13**		**0.3**		**0.3**		**0.24**		**0.15**	

Table 1
SMA-5 - Surficial Soil Analytical Results
ERP Coke Facility, Birmingham, Alabama

Boring Number Depth (feet) Date Sample Collected	**SB44001** **0-1** **6/16/2014**		**SB44002** **0-1** **6/16/2014**		**SB44003** **0-1** **6/16/2014**		**SB45001** **0-1** **6/16/2014**		**SB45003** **0-1** **6/16/2014**	
Fluoranthene	**0.39**		**1.3**		**1**		**1.6**		**0.9**	
Fluorene	**0.017**		**0.058**		**0.077**		**0.093**		**0.12**	
Indeno(1,2,3-cd)pyrene	**0.32**		**0.74**		**0.62**		**0.67**		**0.45**	
Naphthalene	**0.32**		**0.43**		**0.73**		**0.5**		**0.62**	
Phenanthrene	**0.22**		**1.1**		**1.1**		**0.96**		**0.99**	
Pyrene	**0.33**		**1.1**		**1**		**1.3**		**0.88**	
Arsenic	**11**		**5.8**		**9.2**		**14**		**7.1**	
Barium	**120**		**290**		**120**		**100**		**200**	
Cadmium	0.39	j	**0.62**		0.5	j	0.39	j	0.17	j
Chromium	**15**		**20**		**29**		**23**		**23**	
Lead	**27**		**34**		**26**		**13**		**18**	
Selenium	0.81	u	**1.8**		1.1	j	0.83	u	**3.4**	
Silver	0.18	j	0.59	j	0.26	j	0.34	j	0.49	j
Mercury	**0.19**		**0.36**		**1**		**0.17**		**0.082**	

U = qualifier code for nondetected result

J = qualifier code for estimated result

BOLD font indicates a detected chemical concentration.

All results are in mg/kg

Table 2
SMA-5 - Subsurface Soil Analytical Results
ERP Coke Facility, Birmingham, Alabama

Boring Number Depth (feet) Date Sample Collected	SB43001 1-3 6/17/2014	SB43001 5-7 06/17/14	SB43001 7-9 6/17/2014	SB43002 1-3 6/17/2014	SB43002 3-5 6/17/2014	SB43002 7-9 6/17/2014	SB43003 1-3 6/17/2014	SB43003 3-5 6/17/2014	SB43003 5-7 6/17/2014	SB44001 1-3 6/16/2014	SB44001 3-5 6/16/2014	SB44002 1-3 6/16/2014	SB44002 3-5 6/16/2014
1,1,1-Trichloroethane	0.00068 u	0.00068 u	0.00068 u	0.00082 u	0.00073 u	0.00072 u	0.0006 u	0.00085 u	0.00073 u	0.00063 u	0.024 u	0.00067 u	0.00062 u
1,1,2,2-Tetrachloroethane	0.0008 u	0.0008 u	0.0008 u	0.00096 u	0.00085 u	0.00084 u	0.0007 u	0.001 u	0.00085 u	0.00074 u	0.035 u	0.00079 u	0.00072 u
1,1,2-Trichloroethane	0.0012 u	0.0012 u	0.0011 u	0.0014 u	0.0012 u	0.0012 u	0.001 u	0.0014 u	0.0012 u	0.0011 u	0.033 u	0.0011 u	0.001 u
1,1,2-Trichlorotrifluoroethane	0.00059 u	0.00059 u	0.00059 u	0.00071 u	0.00063 u	0.00062 u	0.00052 u	0.00074 u	0.00063 u	0.00055 u	0.08 u	0.00058 u	0.00053 u
1,1-Dichloroethane	0.00028 u	0.00028 u	0.00027 u	0.00033 u	0.00029 u	0.00029 u	0.00024 u	0.00034 u	0.00029 u	0.00026 u	0.061 u	0.00027 u	0.00025 u
1,1-Dichloroethene	0.00077 u	0.00078 u	0.00077 u	0.00093 u	0.00082 u	0.00081 u	0.00068 u	0.00096 u	0.00082 u	0.00072 u	0.061 u	0.00076 u	0.0007 u
1,2,3-Trichlorobenzene	0.0027 j	0.00099 u	0.00098 u	0.0012 u	0.001 u	0.001 u	0.00086 u	0.0012 u	0.001 u	0.00092 u	0.042 u	0.00097 u	0.00089 u
1,2,4-Trichlorobenzene	0.0021 j	0.00096 u	0.00095 u	0.0011 u	0.001 u	0.001 u	0.00084 u	0.0012 u	0.001 u	0.00089 u	0.057 u	0.00094 u	0.00087 u
1,2-Dibromo-3-chloropropane	0.00079 u	0.00079 u	0.00078 u	0.00094 u	0.00084 u	0.00083 u	0.00069 u	0.00098 u	0.00084 u	0.00073 u	0.1 u	0.00077 u	0.00071 u
1,2-Dibromoethane	0.00068 u	0.00068 u	0.00068 u	0.00082 u	0.00073 u	0.00072 u	0.0006 u	0.00085 u	0.00073 u	0.00063 u	0.03 u	0.00067 u	0.00062 u
1,2-Dichlorobenzene	0.00059 u	0.00059 u	0.00059 u	0.00071 u	0.00063 u	0.00062 u	0.00052 u	0.00074 u	0.00063 u	0.00055 u	0.11 u	0.00058 u	0.00053 u
1,2-Dichloroethane	0.00092 u	0.00092 u	0.00091 u	0.0011 u	0.00098 u	0.00097 u	0.00081 u	0.0011 u	0.00098 u	0.00085 u	0.03 u	0.0009 u	0.00083 u
1,2-Dichloropropane	0.00072 u	0.00072 u	0.00072 u	0.00086 u	0.00077 u	0.00076 u	0.00063 u	0.0009 u	0.00077 u	0.00067 u	0.056 u	0.00071 u	0.00065 u
1,3-Dichlorobenzene	0.00063 u	0.00063 u	0.00063 u	0.00075 u	0.00067 u	0.00066 u	0.00055 u	0.00078 u	0.00067 u	0.00059 u	0.049 u	0.00062 u	0.00057 u
1,4-Dichlorobenzene	0.001 u	0.001 u	0.001 u	0.0012 u	0.0011 u	0.0011 u	0.0009 u	0.0013 u	0.0011 u	0.00095 u	0.03 u	0.001 u	0.00092 u
1,4-Dioxane	0.074 u	0.074 u	0.073 u	0.088 u	0.078 u	0.077 u	0.065 u	0.092 u	0.078 u	0.069 u	3 u	0.072 u	0.067 u
2-Butanone	0.0024 u	0.0024 u	0.0024 u	0.0029 u	0.0026 u	0.0025 u	0.0021 u	0.003 u	0.0026 u	0.0022 u	0.36 u	0.0024 u	0.0022 u
2-Hexanone	0.0064 u	0.0064 u	0.0064 u	0.0077 u	0.0068 u	0.0067 u	0.0056 u	0.008 u	0.0068 u	0.006 u	0.26 u	0.0063 u	0.0058 u
4-Methyl-2-pentanone	0.0057 u	0.0057 u	0.0057 u	0.0068 u	0.0061 u	0.006 u	0.005 u	0.0071 u	0.0061 u	0.0053 u	0.27 u	0.0056 u	0.0052 u
Acetone	**0.027**	**0.04**	0.017 j	0.0084 u	0.0075 u	0.0083 j	0.0062 u	0.0088 u	**0.041**	0.0066 u	0.48 u	0.0069 u	0.0064 u
Benzene	0.00062 u	0.001 j	0.00061 u	0.00074 u	0.00066 u	0.00065 u	0.00054 u	0.00077 u	0.0012 j	0.00057 u	**0.35**	0.00061 u	0.00056 u
Bromodichloromethane	0.00029 u	0.00029 u	0.00029 u	0.00035 u	0.00031 u	0.0003 u	0.00025 u	0.00036 u	0.00031 u	0.00027 u	0.048 u	0.00028 u	0.00026 u
Bromoform	0.0003 u	0.0003 u	0.0003 u	0.00036 u	0.00032 u	0.00032 u	0.00026 u	0.00038 u	0.00032 u	0.00028 u	0.19 u	0.0003 u	0.00027 u
Bromomethane	0.00066 u	0.00066 u	0.00065 u	0.00078 u	0.0007 u	0.00069 u	0.00058 u	0.00082 u	0.0007 u	0.00061 u	0.057 u	0.00064 u	0.00059 u
Carbon disulfide	0.00055 u	0.00055 u	0.00055 u	0.00066 u	0.00059 u	0.00058 u	0.00048 u	0.00069 u	0.00059 u	0.00051 u	0.077 u	0.00054 u	0.0005 u
Carbon tetrachloride	0.00083 u	0.00083 u	0.00082 u	0.00099 u	0.00088 u	0.00087 u	0.00072 u	0.001 u	0.00088 u	0.00077 u	0.021 u	0.00081 u	0.00075 u
Chlorobenzene	0.00071 u	0.00071 u	0.0007 u	0.00085 u	0.00075 u	0.00074 u	0.00062 u	0.00088 u	0.00075 u	0.00066 u	0.036 u	0.0007 u	0.00064 u
Chlorobromomethane	0.00039 u	0.00039 u	0.00039 u	0.00047 u	0.00042 u	0.00041 u	0.00035 u	0.00049 u	0.00042 u	0.00037 u	0.057 u	0.00039 u	0.00036 u
Chloroethane	0.0012 u	0.0012 u	0.0012 u	0.0014 u	0.0012 u	0.0012 u	0.001 u	0.0015 u	0.0012 u	0.0011 u	0.053 u	0.0011 u	0.0011 u
Chloroform	0.00038 u	0.00038 u	0.00038 u	0.00046 u	0.00041 u	0.0004 u	0.00033 u	0.00047 u	0.0004 u	0.00035 u	0.056 u	0.00037 u	0.00034 u
Chloromethane	0.001 u	0.001 u	0.001 u	0.0012 u	0.0011 u	0.0011 u	0.00089 u	0.0013 u	0.0011 u	0.00094 u	0.061 u	0.00099 u	0.00091 u
cis-1,2-Dichloroethene	0.00074 u	0.00074 u	0.00073 u	0.00088 u	0.00078 u	0.00077 u	0.00064 u	0.00092 u	0.00078 u	0.00068 u	0.027 u	0.00072 u	0.00066 u
cis-1,3-Dichloropropene	0.0017 u	0.0017 u	0.0017 u	0.002 u	0.0018 u	0.0018 u	0.0015 u	0.0021 u	0.0018 u	0.0016 u	0.033 u	0.0017 u	0.0015 u
Cyclohexane	0.00053 u	0.00053 u	0.00052 u	0.00063 u	0.00056 u	0.00055 u	0.00046 u	0.00065 u	0.00056 u	0.00049 u	0.034 u	0.00052 u	0.00047 u
Cyclohexane, Methyl-	0.00055 u	0.00055 u	0.00055 u	0.00066 u	0.00059 u	0.00058 u	0.00048 u	0.00069 u	0.00059 u	0.00051 u	0.051 u	0.00054 u	0.0005 u
Dibromochloromethane	0.00075 u	0.00075 u	0.00074 u	0.00089 u	0.0008 u	0.00079 u	0.00066 u	0.00093 u	0.0008 u	0.0007 u	0.04 u	0.00074 u	0.00068 u
Dichlorodifluoromethane	0.00068 u	0.00068 u	0.00068 u	0.00082 u	0.00073 u	0.00072 u	0.0006 u	0.00085 u	0.00073 u	0.00063 u	0.027 u	0.00067 u	0.00062 u
Ethylbenzene	0.00088 u	0.00088 u	0.00087 u	0.0011 u	0.00094 u	0.00092 u	0.00077 u	0.0011 u	0.0016 j	0.00082 u	**0.56**	0.00086 u	0.00079 u
Isopropylbenzene	0.00077 u	0.00078 u	0.00077 u	0.00093 u	0.00082 u	0.00081 u	0.00068 u	0.00096 u	0.00082 u	0.00072 u	**0.32**	0.00076 u	0.0007 u
Methyl acetate	0.0036 u	0.0036 u	0.0036 u	0.0043 u	0.0038 u	0.0038 u	0.0032 u	0.0045 u	0.0038 u	0.0034 u	0.29 u	0.0035 u	0.0033 u
Methyl tert-butyl ether	0.00045 u	0.00045 u	0.00044 u	0.00053 u	0.00048 u	0.00047 u	0.00039 u	0.00056 u	0.00047 u	0.00042 u	0.061 u	0.00044 u	0.0004 u
Methylene chloride	0.0021 u	0.0055 j	0.0046 j	0.0053 j	0.0062 j	0.0028 j	0.0018 u	0.0026 u	0.0053 j	0.002 u	0.084 u	0.0021 u	0.0019 u
m-Xylene & p-Xylene	0.0014 u	0.0014 u	0.0014 u	0.0016 u	0.0015 u	0.0014 u	0.0012 u	0.0017 u	0.0026 j	0.0013 u	**2.8**	0.0013 u	0.0012 u

Table 2
SMA-5 - Subsurface Soil Analytical Results
ERP Coke Facility, Birmingham, Alabama

Boring Number	**SB43001**	**SB43001**	**SB43001**	**SB43002**	**SB43002**	**SB43002**	**SB43003**	**SB43003**	**SB43003**	**SB44001**	**SB44001**	**SB44002**	**SB44002**
Depth (feet)	**1-3**	**5-7**	**7-9**	**1-3**	**3-5**	**7-9**	**1-3**	**3-5**	**5-7**	**1-3**	**3-5**	**1-3**	**3-5**
Date Sample Collected	**6/17/2014**	**06/17/14**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**
o-Xylene	0.0008 u	0.0008 u	0.0008 u	0.00096 u	0.00085 u	0.00084 u	0.0007 u	0.001 u	0.0024 j	0.00074 u	**3**	0.00079 u	0.00072 u
Styrene	0.00083 u	0.00083 u	0.00082 u	0.00099 u	0.00088 u	0.00087 u	0.00072 u	0.001 u	0.00088 u	0.00077 u	0.031 u	0.00081 u	0.00075 u
Tetrachloroethene	0.00077 u	0.00078 u	0.00077 u	0.00093 u	0.00082 u	0.00081 u	0.00068 u	0.00096 u	0.00082 u	0.00072 u	0.033 u	0.00076 u	0.0007 u
Toluene	0.00091 u	0.00091 u	0.0009 u	0.0011 u	0.00096 u	0.00095 u	0.00079 u	0.0011 u	0.0019 j	0.00084 u	**1.1**	0.00089 u	0.00082 u
trans-1,2-Dichloroethene	0.00051 u	0.00051 u	0.00051 u	0.00061 u	0.00055 u	0.00054 u	0.00045 u	0.00064 u	0.00054 u	0.00048 u	0.054 u	0.0005 u	0.00046 u
trans-1,3-Dichloropropene	0.00088 u	0.00088 u	0.00087 u	0.0011 u	0.00094 u	0.00092 u	0.00077 u	0.0011 u	0.00093 u	0.00082 u	0.05 u	0.00086 u	0.00079 u
Trichloroethene	0.0003 u	0.0003 u	0.0003 u	0.00036 u	0.00032 u	0.00032 u	0.00026 u	0.00038 u	0.00032 u	0.00028 u	0.028 u	0.0003 u	0.00027 u
Trichlorofluoromethane	0.0014 u	0.0014 u	0.0014 u	0.0016 u	0.0015 u	0.0014 u	0.0012 u	0.0017 u	0.0015 u	0.0013 u	0.061 u	0.0013 u	0.0012 u
Vinylchloride	0.0018 u	0.0018 u	0.0017 u	0.0021 u	0.0019 u	0.0018 u	0.0015 u	0.0022 u	0.0019 u	0.0016 u	0.033 u	0.0017 u	0.0016 u
1,2,4-Trichlorobenzene	0.17 u	0.16 u	0.16 u	0.17 u	0.17 u	0.17 u	0.17 u	0.037 u	0.16 u	0.031 u	0.16 u	0.15 u	0.034 u
1,2-Dichlorobenzene	0.14 u	0.13 u	0.13 u	0.13 u	0.13 u	0.14 u	0.13 u	0.029 u	0.12 u	0.025 u	0.13 u	0.12 u	0.026 u
1,3-Dichlorobenzene	0.075 u	0.068 u	0.07 u	0.072 u	0.072 u	0.074 u	0.072 u	0.016 u	0.068 u	0.013 u	0.069 u	0.065 u	0.014 u
1,4-Dichlorobenzene	0.085 u	0.077 u	0.08 u	0.082 u	0.081 u	0.084 u	0.081 u	0.018 u	0.077 u	0.015 u	0.078 u	0.074 u	0.016 u
1,4-Dioxane	0.41 u	0.38 u	0.39 u	0.4 u	0.39 u	0.41 u	0.39 u	0.088 u	0.37 u	0.074 u	0.38 u	0.36 u	0.079 u
2,4,5-Trichlorophenol	0.062 u	0.057 u	0.059 u	0.06 u	0.06 u	0.062 u	0.06 u	0.013 u	0.056 u	0.011 u	0.057 u	0.054 u	0.012 u
2,4,6-Trichlorophenol	0.062 u	0.057 u	0.059 u	0.06 u	0.06 u	0.062 u	0.06 u	0.013 u	0.056 u	0.011 u	0.057 u	0.054 u	0.012 u
2,4-Dichlorophenol	0.062 u	0.057 u	0.059 u	0.06 u	0.06 u	0.062 u	0.06 u	0.013 u	0.056 u	0.011 u	0.057 u	0.054 u	0.012 u
2,4-Dimethylphenol	0.41 u	0.38 u	0.39 u	0.4 u	0.39 u	0.41 u	0.39 u	0.088 u	0.37 u	0.074 u	0.38 u	0.36 u	0.079 u
2,4-Dinitrophenol	2.1 u	1.9 u	1.9 u	2 u	2 u	2.1 u	2 u	0.44 u	1.9 u	0.37 u	1.9 u	1.8 u	0.4 u
2,4-Dinitrotoluene	0.41 u	0.38 u	0.39 u	0.4 u	0.39 u	0.41 u	0.39 u	0.088 u	0.37 u	0.074 u	0.38 u	0.36 u	0.079 u
2-Chloronaphthalene	0.062 u	0.057 u	0.059 u	0.06 u	0.06 u	0.062 u	0.06 u	0.013 u	0.056 u	0.011 u	0.057 u	0.054 u	0.012 u
2-Chlorophenol	0.13 u	0.12 u	0.12 u	0.13 u	0.13 u	0.13 u	0.13 u	0.028 u	0.12 u	0.023 u	0.12 u	0.11 u	0.025 u
2-Methylnaphthalene	0.33 j	0.11 u	0.28 j	**0.2**	1.2 j	0.16 j	0.4 j	0.31 j	0.18 j	0.042 j	**75**	0.59 j	0.032 j
2-Methylphenol	0.081 u	0.074 u	0.076 u	0.078 u	0.078 u	0.08 u	0.078 u	0.017 u	0.073 u	0.015 u	0.074 u	0.071 u	0.016 u
2-Nitroaniline	0.31 u	0.28 u	0.29 u	0.3 u	0.3 u	0.31 u	0.3 u	0.066 u	0.28 u	0.056 u	0.29 u	0.27 u	0.06 u
2-Nitrophenol	0.062 u	0.057 u	0.059 u	0.06 u	0.06 u	0.062 u	0.06 u	0.013 u	0.056 u	0.011 u	0.057 u	0.054 u	0.012 u
3 & 4 Methylphenol	0.21 u	0.19 u	0.19 u	0.2 u	0.2 u	0.2 u	0.2 u	0.044 u	0.19 u	0.037 u	0.19 u	0.18 u	0.04 u
3,3'-Dichlorobenzidine	0.56 u	0.51 u	0.53 u	0.54 u	0.54 u	0.56 u	0.54 u	0.12 u	0.51 u	0.1 u	0.51 u	0.49 u	0.11 u
3-Nitroaniline	0.46 u	0.42 u	0.43 u	0.44 u	0.44 u	0.45 u	0.44 u	0.097 u	0.41 u	0.082 u	0.42 u	0.4 u	0.088 u
4,6-Dinitro-2-methylphenol	2.1 u	1.9 u	1.9 u	2 u	2 u	2 u	2 u	0.44 u	1.9 u	0.37 u	1.9 u	1.8 u	0.4 u
4-Bromophenyl-phenylether	0.12 u	0.11 u	0.11 u	0.11 u	0.11 u	0.12 u	0.11 u	0.025 u	0.11 u	0.021 u	0.11 u	0.1 u	0.023 u
4-Chloro-3-methylphenol	0.41 u	0.38 u	0.39 u	0.4 u	0.39 u	0.41 u	0.39 u	0.088 u	0.37 u	0.074 u	0.38 u	0.36 u	0.079 u
4-Chloroaniline	0.51 u	0.47 u	0.48 u	0.49 u	0.49 u	0.51 u	0.49 u	0.11 u	0.46 u	0.092 u	0.47 u	0.44 u	0.099 u
4-Chlorophenyl-phenylether	0.13 u	0.12 u	0.12 u	0.13 u	0.13 u	0.13 u	0.13 u	0.028 u	0.12 u	0.023 u	0.12 u	0.11 u	0.025 u
4-Nitroaniline	0.45 u	0.41 u	0.42 u	0.44 u	0.43 u	0.45 u	0.43 u	0.096 u	0.41 u	0.081 u	0.41 u	0.39 u	0.087 u
4-Nitrophenol	0.61 u	0.55 u	0.57 u	0.58 u	0.58 u	0.6 u	0.58 u	0.13 u	0.55 u	0.11 u	0.55 u	0.53 u	0.12 u
Acenaphthene	1 j	0.18 j	0.96 j	**0.11**	0.35 j	0.1 j	0.16 j	0.1 j	0.26 j	0.048 j	**6.5**	0.17 j	0.022 j
Acenaphthylene	0.65 j	0.23 j	**2.9**	**0.41**	0.26 j	0.85 j	0.5 j	0.33 j	**2.1**	0.15 j	**6.4**	0.56 j	0.1 j
Acetophenone	0.12 u	0.11 u	0.12 u	0.12 u	0.12 u	0.12 u	0.12 u	0.027 u	0.11 u	0.022 u	0.11 u	0.11 u	0.024 u
Anthracene	0.86 j	0.56 j	1.4 j	0.41 j	0.87 j	0.59 j	0.58 j	0.4 j	1.7 j	0.096 j	**19**	0.92 j	0.12 j
Benz(a)anthracene	**4.6**	**6.7**	**6.8**	**3.7**	**2.2**	**4.5**	**2.9**	**1.9**	**12**	**0.52**	**20**	**3.7**	**0.52**
Benzo(a)pyrene	**6.1**	**10**	**8.2**	**3.7**	**2.2**	**5.8**	**3.6**	**2.3**	**14**	**0.67**	**14**	**3.4**	**0.56**
Benzo(b)fluoranthene	**9.3**	**16**	**12**	**5.6**	**4**	**8.9**	**5.8**	**3.7**	**22**	**1.2**	**20**	**5.2**	**0.82**

Table 2
SMA-5 - Subsurface Soil Analytical Results
ERP Coke Facility, Birmingham, Alabama

Boring Number	**SB43001**	**SB43001**	**SB43001**	**SB43002**	**SB43002**	**SB43002**	**SB43003**	**SB43003**	**SB43003**	**SB44001**	**SB44001**	**SB44002**	**SB44002**
Depth (feet)	**1-3**	**5-7**	**7-9**	**1-3**	**3-5**	**7-9**	**1-3**	**3-5**	**5-7**	**1-3**	**3-5**	**1-3**	**3-5**
Date Sample Collected	**6/17/2014**	**06/17/14**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**
Benzo(g,h,i)perylene	**4.7**	**9**	**6.6**	**2.7**	1.9 j	**4.7**	**3.1**	**1.9**	**12**	**0.68**	**7.8**	**2.4**	**0.46**
Benzo(k)fluoranthene	**3.4**	**5.5**	**4**	**2.3**	1.2 j	**3**	**2.3**	**1.5**	**7.4**	**0.39**	**7.6**	**1.8**	0.3 j
Benzyl alcohol	0.062 u	0.057 u	0.059 u	0.06 u	0.06 u	0.062 u	0.06 u	0.013 u	0.056 u	0.011 u	0.057 u	0.054 u	0.012 u
bis(2-Chloroethoxy)methane	0.14 u	0.13 u	0.13 u	0.14 u	0.14 u	0.14 u	0.14 u	0.031 u	0.13 u	0.026 u	0.13 u	0.12 u	0.028 u
bis(2-Chloroethyl)ether	0.1 u	0.094 u	0.097 u	0.1 u	0.099 u	0.1 u	0.099 u	0.022 u	0.094 u	0.019 u	0.095 u	0.09 u	0.02 u
bis(2-Chloroisopropyl)ether	0.14 u	0.13 u	0.13 u	0.14 u	0.14 u	0.14 u	0.14 u	0.031 u	0.13 u	0.026 u	0.13 u	0.12 u	0.028 u
bis(2-Ethylhexyl)phthalate	0.58 j	0.26 u	0.27 u	0.28 u	0.71 j	0.28 u	0.66 j	0.23 j	0.26 u	0.051 u	0.26 u	0.25 u	0.055 u
Butyl benzyl phthalate	0.27 u	0.24 u	0.25 u	0.26 u	0.26 u	0.27 u	0.26 u	0.095 j	0.24 u	0.048 u	0.25 u	0.23 u	0.052 u
Carbazole	0.41 j	0.21 j	0.6 j	0.22 u	0.25 j	0.23 j	0.28 j	0.16 j	0.46 j	0.043 j	**6.3**	0.46 j	0.056 j
Chrysene	**6.1**	**8.5**	**7.8**	**3.9**	**3.5**	**5.1**	**3.8**	**2.5**	**14**	**0.66**	**18**	**4.4**	**0.62**
Dibenz(a,h)anthracene	1.5 j	2.6	2.1	0.84 j	0.73 j	1.3 j	1 j	**0.61**	**3.7**	0.22 j	**2.6**	1 j	0.16 j
Dibenzofuran	0.38 j	0.16 j	0.45 j	0.16 j	0.82 j	0.15 j	0.33 j	0.25 j	0.29 j	0.036 j	**27**	0.33 j	0.026 j
Diethylphthalate	0.16 u	0.15 u	0.15 u	0.16 u	0.16 u	0.16 u	0.16 u	0.034 u	0.15 u	0.029 u	0.15 u	0.14 u	0.031 u
Dimethyl phthalate	0.14 j	0.13 u	0.13 u	0.14 u	0.14 u	0.17 j	0.14 u	0.053 j	0.13 u	0.069 j	0.39 u	0.12 u	0.19 j
Di-N-Butyl phthalate	0.18 u	0.17 u	0.17 u	0.17 u	0.17 u	0.18 u	0.17 u	0.038 u	0.16 u	0.032 u	0.17 u	0.16 u	0.035 u
Di-N-Octyl phthalate	0.09 u	0.082 u	0.084 u	0.087 u	0.086 u	0.089 u	0.086 u	0.019 u	0.081 u	0.016 u	0.082 u	0.078 u	0.017 u
Fluoranthene	**6**	**5.6**	**9.4**	**6**	**4.1**	**6**	**3.7**	**2.6**	**18**	**0.66**	**60**	**4.6**	**0.63**
Fluorene	0.33 j	0.22 j	0.47 j	0.11 u	0.41 j	0.19 j	0.17 j	0.12 j	0.45 j	0.023 j	**36**	0.4 j	0.038 j
Hexachlorobenzene	0.18 u	0.17 u	0.17 u	0.17 u	0.17 u	0.18 u	0.17 u	0.038 u	0.16 u	0.032 u	0.17 u	0.16 u	0.035 u
Hexachlorobutadiene	0.062 u	0.057 u	0.059 u	0.06 u	0.06 u	0.062 u	0.06 u	0.013 u	0.056 u	0.011 u	0.057 u	0.054 u	0.012 u
Hexachlorocyclopentadiene	0.31 u	0.28 u	0.29 u	0.3 u	0.3 u	0.31 u	0.3 u	0.066 u	0.28 u	0.056 u	0.29 u	0.27 u	0.06 u
Hexachloroethane	0.13 u	0.12 u	0.12 u	0.13 u	0.13 u	0.13 u	0.13 u	0.028 u	0.12 u	0.024 u	0.12 u	0.12 u	0.026 u
Indeno(1,2,3-cd)pyrene	**5.3**	**8.8**	**6.9**	**3**	**1.8 j**	**5.2**	**3.5**	**2.1**	**13**	**0.74**	**9.9**	**2.6**	**0.54**
Isophorone	0.11 u	0.097 u	0.099 u	0.1 u	0.1 u	0.1 u	0.1 u	0.023 u	0.096 u	0.019 u	0.097 u	0.092 u	0.02 u
Naphthalene	0.67 j	0.29 j	0.63 j	0.29 j	1.1 j	0.3 j	0.56 j	0.43 j	0.72 j	0.12 j	**380**	**1.8**	0.088 j
Nitrobenzene	0.14 u	0.13 u	0.13 u	0.13 u	0.13 u	0.14 u	0.13 u	0.029 u	0.12 u	0.025 u	0.13 u	0.12 u	0.026 u
N-Nitroso-di-N-propylamine	0.19 u	0.18 u	0.18 u	0.19 u	0.19 u	0.19 u	0.19 u	0.041 u	0.17 u	0.035 u	0.18 u	0.17 u	0.037 u
N-Nitrosodiphenylamine	0.13 u	0.12 u	0.12 u	0.13 u	0.13 u	0.13 u	0.13 u	0.028 u	0.12 u	0.023 u	0.12 u	0.11 u	0.025 u
Pentachlorophenol	2.1 u	1.9 u	1.9 u	2 u	2 u	2 u	2 u	0.44 u	1.9 u	0.37 u	1.9 u	1.8 u	0.4 u
Phenanthrene	**2.3**	1.7 j	**3.2**	1.2 j	**3.3**	**2**	1.9 j	**1.4**	**6.1**	0.32 j	**89**	**2.7**	0.32 j
Phenol	0.11 u	0.1 u	0.11 u	0.11 u	0.11 u	0.11 u	0.11 u	0.024 u	0.1 u	0.02 u	0.1 u	0.098 u	0.022 u
Pyrene	**5.8**	**6.2**	**8.1**	**5.9**	**3.4**	**5.3**	**3.5**	**2.4**	**15**	**0.66**	**41**	**4**	**0.59**
2-Methylnaphthalene	**1.4**	**0.14**	**0.36**	**0.69**	**1.4**	**0.27**	**1.1**	**0.74**	**0.28**	**0.17**	**40**	**0.94**	**0.12**
Acenaphthene	**1.3**	**0.18**	**0.93**	**0.092**	**0.3**	**0.097**	**0.14**	**0.069**	**0.23**	**0.073**	**3.7**	**0.14**	**0.029**
Acenaphthylene	**0.6**	**0.19**	**1.8**	**0.33**	**0.19**	**1.1**	**0.41**	**0.15**	**1.6**	**0.2**	**4.3**	**0.5**	**0.13**
Anthracene	**1**	**0.41 j**	**1.3**	**0.39**	**0.85**	**0.58**	**0.76**	**0.32**	**1**	**0.15**	**12**	**0.92**	**0.21**
Benz(a)anthracene	**3.7**	**2.9**	**5.9**	**1.6**	**1.4**	**3.2**	**1.5**	**0.77**	**6.8**	**0.65**	**12**	**3**	**0.75**
Benzo(a)pyrene	**4.4**	**4.7**	**8.6**	**1.8**	**1.1**	**4.2**	**1.5**	**0.79**	**9.1**	**0.81**	**8.6**	**2.6**	**0.76**
Benzo(b)fluoranthene	**7.4**	**8.2**	**13**	**3**	**2.1**	**6.9**	**3**	**1.5**	**15**	**1.4**	**13**	**4.2**	**1.2**
Benzo(g,h,i)perylene	**2.8**	**4.7**	**7.4**	**1.2**	**0.79**	**3.4**	**1**	**0.54**	**8**	**0.68**	**5.2**	**1.6**	**0.53**
Benzo(k)fluoranthene	**2.6**	**2.6**	**4.7**	**1.1**	**0.61**	**2.2**	**1.1**	**0.51**	**5.3**	**0.5**	**4.7**	**1.5**	**0.42**
Chrysene	**5.1**	**4**	**7.9**	**2.1**	**2.5**	**4.1**	**2.2**	**1.2**	**8.5**	**0.82**	**12**	**3.6**	**0.98**
Dibenz(a,h)anthracene	**1.1**	**1.5**	**2.2**	**0.43**	**0.34**	**1.1**	**0.42**	**0.23**	**2.5**	**0.23**	1.5 j	**0.71**	**0.21**

Table 2
SMA-5 - Subsurface Soil Analytical Results
ERP Coke Facility, Birmingham, Alabama

Boring Number	**SB43001**	**SB43001**	**SB43001**	**SB43002**	**SB43002**	**SB43002**	**SB43003**	**SB43003**	**SB43003**	**SB44001**	**SB44001**	**SB44002**	**SB44002**
Depth (feet)	**1-3**	**5-7**	**7-9**	**1-3**	**3-5**	**7-9**	**1-3**	**3-5**	**5-7**	**1-3**	**3-5**	**1-3**	**3-5**
Date Sample Collected	**6/17/2014**	**06/17/14**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/17/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**	**6/16/2014**
Fluoranthene	**4.7**	**3.5**	**8.4**	**2**	**2.7**	**4.3**	**2.4**	**1.3**	**10**	**0.97**	**36**	**3.5**	**0.94**
Fluorene	**0.57**	0.2 j	**0.65**	**0.096**	**0.39**	**0.13**	**0.26**	**0.11**	**0.36**	**0.043**	**23**	**0.4**	**0.071**
Indeno(1,2,3-cd)pyrene	**3**	**4.1**	**6.4**	**1.2**	**0.73**	**3.7**	**1.1**	**0.56**	**7.6**	**0.71**	**5.3**	**1.6**	**0.52**
Naphthalene	**3.1**	0.029 u	**2**	**1**	**1.3**	**0.69**	**1.5**	**1.2**	**1.4**	**0.45**	**210**	**3.4**	**0.25**
Phenanthrene	**3.3**	**1.6**	**3.7**	**1.2**	**3**	**1.4**	**2.3**	**1.4**	**4**	**0.5**	**54**	**3**	**0.61**
Pyrene	**4.4**	**3.1**	**6.7**	**1.9**	**2.2**	**3.8**	**2.1**	**1**	**8.3**	**0.9**	**23**	**2.9**	**0.78**
Arsenic	**22**	**3.8**	**8.8**	**13**	**7.4**	**14**	**21**	**18**	**25**	**24**	**10**	**13**	**15**
Barium	**230**	**37**	**52**	**270**	**240**	**160**	**220**	**190**	**100**	**160**	**63**	**220**	**150**
Cadmium	**4.6**	**0.77**	**0.58**	**3.1**	0.46 j	**1.4**	**2.6**	**2.3**	**1.9**	**0.8**	0.05 u	**2.3**	0.29 j
Chromium	**88**	**7.5**	**19**	**81**	**21**	**41**	**49**	**55**	**40**	**25**	**30**	**29**	**54**
Lead	**300**	**28**	**45**	**240**	**29**	**98**	**150**	**170**	**140**	**46**	**16**	**820**	**30**
Selenium	9.8 u	0.93 u	**2.4**	9.5 u	**1.6**	0.98 u	1.1 j	1.1 u	**1.9**	0.86 u	1 u	**1.6**	**1.5**
Silver	**5.4**	0.27 j	0.22 j	**1.6**	0.48 j	0.69 j	1 j	1.2 j	0.54 j	0.8 j	0.19 u	0.65 j	0.52 j
Mercury	**0.77**	**0.71**	**4.6**	**0.45**	**0.13**	**2.5**	**0.29**	**0.31**	**2.9**	**0.28**	**0.1**	**5**	**0.17**

U = qualifier code for nondetected result
J = qualifier code for estimated result
BOLD font indicates a detected chemical concentration.
All results are in mg/kg

Table 2
SMA-5 - Subsurface Soil Analytical Results
ERP Coke Facility, Birmingham, Alabama

Boring Number	SB44003		SB44003		SB45001		SB45001		SB45002		SB45002		SB45003		SB45004	
Depth (feet)	1-3		3-5		1-3		3-5		1-3		3-5		1-2.5		1-2.5	
Date Sample Collected	6/16/2014		6/16/2014		6/16/2014		6/16/2014		6/16/2014		6/16/2014		6/16/2014		6/16/2014	
1,1,1-Trichloroethane	0.00076	u	0.00056	u	0.00069	u	0.00064	u	0.00051	u	0.00064	u	0.00052	u	0.00071	u
1,1,2,2-Tetrachloroethane	0.00089	u	0.00065	u	0.00081	u	0.00075	u	0.0006	u	0.00075	u	0.00061	u	0.00084	u
1,1,2-Trichloroethane	0.0013	u	0.00094	u	0.0012	u	0.0011	u	0.00086	u	0.0011	u	0.00087	u	0.0012	u
1,1,2-Trichlorotrifluoroethane	0.00066	u	0.00048	u	0.0006	u	0.00055	u	0.00044	u	0.00055	u	0.00045	u	0.00062	u
1,1-Dichloroethane	0.00031	u	0.00022	u	0.00028	u	0.00026	u	0.00021	u	0.00026	u	0.00021	u	0.00029	u
1,1-Dichloroethene	0.00086	u	0.00063	u	0.00079	u	0.00073	u	0.00058	u	0.00073	u	0.00059	u	0.00081	u
1,2,3-Trichlorobenzene	0.0011	u	0.0008	u	0.001	u	0.00092	u	0.00073	u	0.00092	u	0.00074	u	0.001	u
1,2,4-Trichlorobenzene	0.0011	u	0.00078	u	0.00097	u	0.0009	u	0.00071	u	0.0009	u	0.00072	u	0.001	u
1,2-Dibromo-3-chloropropane	0.00088	u	0.00064	u	0.0008	u	0.00074	u	0.00059	u	0.00074	u	0.0006	u	0.00082	u
1,2-Dibromoethane	0.00076	u	0.00056	u	0.00069	u	0.00064	u	0.00051	u	0.00064	u	0.00052	u	0.00071	u
1,2-Dichlorobenzene	0.00066	u	0.00048	u	0.0006	u	0.00055	u	0.00044	u	0.00055	u	0.00045	u	0.00062	u
1,2-Dichloroethane	0.001	u	0.00075	u	0.00093	u	0.00086	u	0.00069	u	0.00086	u	0.00069	u	0.00096	u
1,2-Dichloropropane	0.00081	u	0.00059	u	0.00073	u	0.00068	u	0.00054	u	0.00068	u	0.00055	u	0.00076	u
1,3-Dichlorobenzene	0.0007	u	0.00051	u	0.00064	u	0.00059	u	0.00047	u	0.00059	u	0.00048	u	0.00066	u
1,4-Dichlorobenzene	0.0011	u	0.00083	u	0.001	u	0.00096	u	0.00076	u	0.00096	u	0.00077	u	0.0011	u
1,4-Dioxane	0.082	u	0.06	u	0.075	u	0.069	u	0.055	u	0.069	u	0.056	u	0.077	u
2-Butanone	0.0027	u	0.002	u	0.0024	u	0.0023	u	0.0018	u	0.0023	u	0.0018	u	0.0025	u
2-Hexanone	0.0072	u	0.0052	u	0.0065	u	0.006	u	0.0048	u	0.006	u	0.0049	u	0.0067	u
4-Methyl-2-pentanone	0.0064	u	0.0047	u	0.0058	u	0.0054	u	0.0043	u	0.0054	u	0.0043	u	0.006	u
Acetone	0.0079	u	0.016	j	0.0098	j	0.0066	u	0.0053	u	0.0066	u	0.0053	u	0.018	j
Benzene	0.00079	j	0.0013	j	0.0054	j	0.00058	u	0.00046	u	0.00058	u	0.00047	u	0.00065	u
Bromodichloromethane	0.00032	u	0.00024	u	0.00029	u	0.00027	u	0.00022	u	0.00027	u	0.00022	u	0.0003	u
Bromoform	0.00034	u	0.00025	u	0.00031	u	0.00028	u	0.00023	u	0.00028	u	0.00023	u	0.00032	u
Bromomethane	0.00073	u	0.00053	u	0.00067	u	0.00062	u	0.00049	u	0.00062	u	0.0005	u	0.00069	u
Carbon disulfide	0.00062	u	0.00045	u	0.0031	j b	0.00052	u	0.00041	u	0.00052	u	0.00042	u	0.00058	u
Carbon tetrachloride	0.00092	u	0.00067	u	0.00084	u	0.00078	u	0.00062	u	0.00078	u	0.00062	u	0.00086	u
Chlorobenzene	0.00079	u	0.00058	u	0.00072	u	0.00067	u	0.00053	u	0.00067	u	0.00054	u	0.00074	u
Chlorobromomethane	0.00044	u	0.00032	u	0.0004	u	0.00037	u	0.00029	u	0.00037	u	0.0003	u	0.00041	u
Chloroethane	0.0013	u	0.00095	u	0.0012	u	0.0011	u	0.00087	u	0.0011	u	0.00088	u	0.0012	u
Chloroform	0.00042	u	0.00031	u	0.00039	u	0.00036	u	0.00028	u	0.00036	u	0.00029	u	0.0004	u
Chloromethane	0.0011	u	0.00082	u	0.001	u	0.00095	u	0.00075	u	0.00095	u	0.00076	u	0.0011	u
cis-1,2-Dichloroethene	0.00082	u	0.0006	u	0.00075	u	0.00069	u	0.00055	u	0.00069	u	0.00056	u	0.00077	u
cis-1,3-Dichloropropene	0.0019	u	0.0014	u	0.0017	u	0.0016	u	0.0013	u	0.0016	u	0.0013	u	0.0018	u
Cyclohexane	0.00059	u	0.00043	u	0.00053	u	0.00049	u	0.00039	u	0.00049	u	0.0004	u	0.00055	u
Cyclohexane, Methyl-	0.00062	u	0.00045	u	0.00056	u	0.00052	u	0.00041	u	0.00052	u	0.00042	u	0.00058	u
Dibromochloromethane	0.00083	u	0.00061	u	0.00076	u	0.0007	u	0.00056	u	0.0007	u	0.00057	u	0.00078	u
Dichlorodifluoromethane	0.00076	u	0.00056	u	0.00069	u	0.00064	u	0.00051	u	0.00064	u	0.00052	u	0.00071	u
Ethylbenzene	0.0037	j	0.00072	u	0.00089	u	0.00083	u	0.00066	u	0.00083	u	0.00066	u	0.00092	u
Isopropylbenzene	0.00086	u	0.00063	u	0.00079	u	0.00073	u	0.00058	u	0.00073	u	0.00059	u	0.00081	u
Methyl acetate	0.004	u	0.0029	u	0.0037	u	0.0034	u	0.0027	u	0.0034	u	0.0027	u	0.0038	u
Methyl tert-butyl ether	0.0005	u	0.00036	u	0.00045	u	0.00042	u	0.00033	u	0.00042	u	0.00034	u	0.00047	u
Methylene chloride	0.0033	j	0.0018	j	0.0027	j	0.002	u	0.0016	u	0.002	u	0.0016	u	0.0028	j
m-Xylene & p-Xylene	**0.013**		0.0011	u	0.0028	j	0.0013	u	0.001	u	0.0013	u	0.001	u	0.0017	j

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Boring Number	**SB44003**		**SB44003**		**SB45001**		**SB45001**		**SB45002**		**SB45002**		**SB45003**		**SB45004**	
Depth (feet)	**1-3**		**3-5**		**1-3**		**3-5**		**1-3**		**3-5**		**1-2.5**		**1-2.5**	
Date Sample Collected	**6/16/2014**		**6/16/2014**		**6/16/2014**		**6/16/2014**		**6/16/2014**		**6/16/2014**		**6/16/2014**		**6/16/2014**	
o-Xylene	**0.0045**		0.00065	u	0.0019	j	0.00075	u	0.0006	u	0.00075	u	0.00061	u	0.0014	j
Styrene	0.00092	u	0.00067	u	0.00084	u	0.00078	u	0.00062	u	0.00078	u	0.00062	u	0.00086	u
Tetrachloroethene	0.00086	u	0.00063	u	0.00079	u	0.00073	u	0.00058	u	0.00073	u	0.00059	u	0.00081	u
Toluene	**0.0089**		0.00074	u	0.002	j	0.00085	u	0.00068	u	0.00085	u	0.00068	u	0.00095	u
trans-1,2-Dichloroethene	0.00057	u	0.00042	u	0.00052	u	0.00048	u	0.00038	u	0.00048	u	0.00039	u	0.00054	u
trans-1,3-Dichloropropene	0.00098	u	0.00072	u	0.00089	u	0.00083	u	0.00066	u	0.00083	u	0.00066	u	0.00092	u
Trichloroethene	0.00034	u	0.00025	u	0.00031	u	0.00028	u	0.00023	u	0.00028	u	0.00023	u	0.00032	u
Trichlorofluoromethane	0.0015	u	0.0011	u	0.0014	u	0.0013	u	0.001	u	0.0013	u	0.001	u	0.0014	u
Vinylchloride	0.002	u	0.0014	u	0.0018	u	0.0017	u	0.0013	u	0.0017	u	0.0013	u	0.0018	u
1,2,4-Trichlorobenzene	0.16	u	0.17	u	0.31	u	0.032	u	0.15	u	0.15	u	0.031	u	0.037	u
1,2-Dichlorobenzene	0.13	u	0.13	u	0.24	u	0.025	u	0.12	u	0.12	u	0.024	u	0.029	u
1,3-Dichlorobenzene	0.07	u	0.071	u	0.13	u	0.014	u	0.066	u	0.065	u	0.013	u	0.016	u
1,4-Dichlorobenzene	0.079	u	0.081	u	0.15	u	0.015	u	0.074	u	0.073	u	0.015	u	0.018	u
1,4-Dioxane	0.38	u	0.39	u	0.72	u	0.075	u	0.36	u	0.35	u	0.072	u	0.087	u
2,4,5-Trichlorophenol	0.058	u	0.059	u	0.11	u	0.011	u	0.055	u	0.054	u	0.011	u	0.013	u
2,4,6-Trichlorophenol	0.058	u	0.059	u	0.11	u	0.011	u	0.055	u	0.054	u	0.011	u	0.013	u
2,4-Dichlorophenol	0.058	u	0.059	u	0.11	u	0.011	u	0.055	u	0.054	u	0.011	u	0.013	u
2,4-Dimethylphenol	0.38	u	0.39	u	0.72	u	0.075	u	0.36	u	0.35	u	0.072	u	0.087	u
2,4-Dinitrophenol	1.9	u	2	u	3.6	u	0.38	u	1.8	u	1.8	u	0.36	u	0.44	u
2,4-Dinitrotoluene	0.38	u	0.39	u	0.72	u	0.075	u	0.36	u	0.35	u	0.072	u	0.087	u
2-Chloronaphthalene	0.058	u	0.059	u	0.11	u	0.011	u	0.055	u	0.054	u	0.011	u	0.013	u
2-Chlorophenol	0.12	u	0.12	u	0.23	u	0.024	u	0.11	u	0.11	u	0.023	u	0.028	u
2-Methylnaphthalene	0.3	j	0.23	j	0.76	j	0.043	j	0.22	j	0.1	u	0.2	j	0.23	j
2-Methylphenol	0.076	u	0.077	u	0.14	u	0.015	u	0.071	u	0.07	u	0.014	u	0.017	u
2-Nitroaniline	0.29	u	0.3	u	0.55	u	0.056	u	0.27	u	0.27	u	0.055	u	0.066	u
2-Nitrophenol	0.058	u	0.059	u	0.11	u	0.011	u	0.055	u	0.054	u	0.011	u	0.013	u
3 & 4 Methylphenol	0.19	u	0.2	u	0.36	u	0.037	u	0.18	u	0.18	u	0.036	u	0.043	u
3,3'-Dichlorobenzidine	0.52	u	0.53	u	0.98	u	0.1	u	0.49	u	0.48	u	0.098	u	0.12	u
3-Nitroaniline	0.42	u	0.43	u	0.8	u	0.082	u	0.4	u	0.39	u	0.08	u	0.096	u
4,6-Dinitro-2-methylphenol	1.9	u	2	u	3.6	u	0.37	u	1.8	u	1.8	u	0.36	u	0.43	u
4-Bromophenyl-phenylether	0.11	u	0.11	u	0.21	u	0.021	u	0.1	u	0.1	u	0.021	u	0.025	u
4-Chloro-3-methylphenol	0.38	u	0.39	u	0.72	u	0.075	u	0.36	u	0.35	u	0.072	u	0.087	u
4-Chloroaniline	0.48	u	0.49	u	0.9	u	0.093	u	0.45	u	0.44	u	0.09	u	0.11	u
4-Chlorophenyl-phenylether	0.12	u	0.12	u	0.23	u	0.024	u	0.11	u	0.11	u	0.023	u	0.028	u
4-Nitroaniline	0.42	u	0.43	u	0.79	u	0.082	u	0.4	u	0.39	u	0.079	u	0.095	u
4-Nitrophenol	0.56	u	0.58	u	1.1	u	0.11	u	0.53	u	0.52	u	0.11	u	0.13	u
Acenaphthene	0.61	j	0.28	j	0.44	j	0.099	j	0.49	j	0.055	u	0.035	j	0.014	u
Acenaphthylene	0.12	j	0.66	j	**4.6**		**0.43**		0.093	u	0.091	u	0.049	j	0.022	u
Acetophenone	0.12	u	0.13	j	0.37	j	0.023	u	0.11	u	0.11	u	0.022	u	0.026	u
Anthracene	0.89	j	0.98	j	**4.9**		0.26	j	1	j	0.14	j	0.11	j	0.11	j
Benz(a)anthracene	**9.5**		**2.1**		**17**		**1.4**		**15**		1.2	j	0.29	j	0.075	j
Benzo(a)pyrene	**18**		1.8	j	**17**		**1.8**		**25**		**2**		0.33	j	0.11	j
Benzo(b)fluoranthene	**23**		**2.8**		**25**		**2.8**		**43**		**2.9**		**0.55**		0.14	j

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Boring Number	**SB44003**		**SB44003**		**SB45001**		**SB45001**		**SB45002**		**SB45002**		**SB45003**		**SB45004**	
Depth (feet)	**1-3**		**3-5**		**1-3**		**3-5**		**1-3**		**3-5**		**1-2.5**		**1-2.5**	
Date Sample Collected	**6/16/2014**		**6/16/2014**		**6/16/2014**		**6/16/2014**		**6/16/2014**		**6/16/2014**		**6/16/2014**		**6/16/2014**	
Benzo(g,h,i)perylene	**16**		1.3	j	**12**		**1.6**		**26**		**2.1**		0.32	j	0.094	j
Benzo(k)fluoranthene	**7.7**		1.1	j	**9.6**		**0.99**		**13**		1.2	j	0.2	j	0.053	u
Benzyl alcohol	0.058	u	0.059	u	0.11	u	0.011	u	0.055	u	0.054	u	0.011	u	0.013	u
bis(2-Chloroethoxy)methane	0.13	u	0.14	u	0.25	u	0.026	u	0.13	u	0.12	u	0.025	u	0.03	u
bis(2-Chloroethyl)ether	0.097	u	0.099	u	0.18	u	0.019	u	0.091	u	0.089	u	0.018	u	0.022	u
bis(2-Chloroisopropyl)ether	0.13	u	0.14	u	0.25	u	0.026	u	0.13	u	0.12	u	0.025	u	0.03	u
bis(2-Ethylhexyl)phthalate	0.27	u	0.27	u	0.5	u	0.052	u	0.25	u	0.25	u	0.34	j	0.06	u
Butyl benzyl phthalate	0.25	u	0.26	u	0.47	u	0.049	u	0.23	u	0.23	u	0.047	u	0.057	u
Carbazole	1.1	j	0.21	u	1.2	j	0.11	j	0.4	j	0.19	u	0.048	j	0.047	u
Chrysene	**13**		**2.1**		**18**		**1.5**		**20**		1.5	j	**0.51**		0.085	j
Dibenz(a,h)anthracene	**4.3**		0.11	u	**4.5**		**0.45**		**7.8**		0.69	j	0.12	j	0.025	u
Dibenzofuran	0.22	j	0.55	j	1.2	j	0.059	j	0.3	j	0.11	u	0.085	j	0.081	j
Diethylphthalate	0.15	u	0.15	u	0.28	u	0.029	u	0.14	u	0.14	u	0.028	u	0.034	u
Dimethyl phthalate	0.13	u	0.14	u	0.25	u	0.17	j	0.13	u	0.12	u	0.083	j	0.03	u
Di-N-Butyl phthalate	0.17	u	0.17	u	0.32	u	0.033	u	0.16	u	0.16	u	0.032	u	0.038	u
Di-N-Octyl phthalate	0.084	u	0.086	u	0.16	u	0.016	u	0.079	u	0.077	u	0.016	u	0.019	u
Fluoranthene	**11**		**5.1**		**33**		**1.8**		**13**		1.2	j	**0.49**		0.17	j
Fluorene	0.36	j	0.57	j	2.1	j	0.058	j	0.5	j	0.097	u	0.084	j	0.15	j
Hexachlorobenzene	0.17	u	0.17	u	0.32	u	0.033	u	0.16	u	0.16	u	0.032	u	0.038	u
Hexachlorobutadiene	0.058	u	0.059	u	0.11	u	0.011	u	0.055	u	0.054	u	0.011	u	0.013	u
Hexachlorocyclopentadiene	0.29	u	0.3	u	0.55	u	0.056	u	0.27	u	0.27	u	0.055	u	0.066	u
Hexachloroethane	0.12	u	0.13	u	0.23	u	0.024	u	0.12	u	0.11	u	0.023	u	0.028	u
Indeno(1,2,3-cd)pyrene	**16**		**1.6**	**j**	**12**		**1.8**		**27**		**2.1**		0.34	j	0.029	u
Isophorone	0.099	u	0.1	u	0.19	u	0.019	u	0.093	u	0.091	u	0.019	u	0.022	u
Naphthalene	0.33	j	1.4	j	3.3	j	0.22	j	0.31	j	0.17	u	0.23	j	**0.84**	
Nitrobenzene	0.13	u	0.13	u	0.24	u	0.025	u	0.12	u	0.12	u	0.024	u	0.029	u
N-Nitroso-di-N-propylamine	0.18	u	0.18	u	0.34	u	0.035	u	0.17	u	0.17	u	0.034	u	0.041	u
N-Nitrosodiphenylamine	0.12	u	0.12	u	0.23	u	0.024	u	0.11	u	0.11	u	0.023	u	0.028	u
Pentachlorophenol	1.9	u	2	u	3.6	u	0.37	u	1.8	u	1.8	u	0.36	u	0.43	u
Phenanthrene	**4.7**		**2.1**		**14**		**0.75**		**4.5**		0.48	j	**0.47**		0.28	j
Phenol	0.1	u	0.11	u	0.2	u	0.02	u	0.098	u	0.097	u	0.02	u	0.024	u
Pyrene	**12**		**4.1**		**25**		**1.7**		**13**		1.1	j	**0.46**		0.2	j
2-Methylnaphthalene	**0.61**		**0.78**		**0.95**		**0.086**		**0.37**		**0.067**		**0.25**		**0.19**	
Acenaphthene	**0.42**		**0.31**		**0.42**		**0.079**		**0.52**		**0.045**		**0.028**		**0.018**	
Acenaphthylene	**0.099**		**0.58**		**6**		**0.28**		0.026	j	**0.036**		**0.039**		**0.018**	
Anthracene	**0.68**		**0.96**		**5**		**0.22**		**0.39**	**u**	**0.15**		**0.14**		**0.061**	
Benz(a)anthracene	**5.3**		**1.5**		**13**		**0.87**		**14**		**1.1**		**0.25**		**0.051**	
Benzo(a)pyrene	**10**		**1.3**		**13**		**0.98**		**26**		**1.7**		**0.22**		**0.04**	
Benzo(b)fluoranthene	**14**		**2.1**		**20**		**1.8**		**43**		**3**		**0.42**		**0.062**	
Benzo(g,h,i)perylene	**8.8**		**0.87**		**9.3**		**0.74**		**27**		**1.5**		**0.17**		**0.03**	
Benzo(k)fluoranthene	**4.9**		**0.79**		**7.1**		**0.63**		**14**		**1**		**0.14**		**0.02**	
Chrysene	**8.1**		**1.7**		**15**		**1.1**		**20**		**1.6**		**0.44**		**0.056**	
Dibenz(a,h)anthracene	**2.3**		**0.33**		**3**		**0.25**		**7.9**		**0.45**		**0.076**		**0.0095**	

Table 2
SMA-5 - Subsurface Soil Analytical Results
ERP Coke Facility, Birmingham, Alabama

Boring Number	SB44003	SB44003	SB45001	SB45001	SB45002	SB45002	SB45003	SB45004
Depth (feet)	1-3	3-5	1-3	3-5	1-3	3-5	1-2.5	1-2.5
Date Sample Collected	6/16/2014	6/16/2014	6/16/2014	6/16/2014	6/16/2014	6/16/2014	6/16/2014	6/16/2014
Fluoranthene	**7**	**3.8**	**27**	**1.7**	**13**	**1.2**	**0.43**	**0.14**
Fluorene	**0.24**	**0.98**	**1.7**	**0.076**	**0.6**	**0.046**	**0.073**	**0.083**
Indeno(1,2,3-cd)pyrene	**7.7**	**0.86**	**12**	**0.77**	**24**	**1.6**	**0.15**	**0.03**
Naphthalene	**0.71**	**7**	**5.8**	**0.48**	**0.49**	**0.098**	**0.25**	**0.67**
Phenanthrene	**2.9**	**2.7**	**10**	**0.85**	**4.7**	**0.45**	**0.51**	**0.21**
Pyrene	**6.6**	**2.7**	**20**	**1.3**	**12**	**1.1**	**0.38**	**0.15**
Arsenic	**10**	**10**	**16**	**10**	**3.8**	**5.2**	**3.5**	2 j
Barium	**210**	**79**	**130**	**94**	**27**	**360**	**380**	**350**
Cadmium	**1.3**	0.32 j	**0.51**	**0.58**	0.15 j	0.18 j	0.086 j	0.05 u
Chromium	**31**	**20**	**23**	**26**	**7.1**	**25**	**28**	**22**
Lead	**90**	**32**	**62**	**54**	**9**	**16**	**5.8**	**3.4**
Selenium	1 u	0.99 u	0.85 u	0.99 u	0.81 u	**2.5**	**1.8**	**1.7**
Silver	0.84 j	0.22 j	0.28 j	0.53 j	0.15 u	0.48 j	0.64 j	0.48 j
Mercury	**0.36**	**0.25**	**0.75**	**0.78**	**0.03**	**0.26**	**0.042**	0.008 u

U = qualifier code for nondetected result
J = qualifier code for estimated result
BOLD font indicates a detected chemical concentration.
All results are in mg/kg

APPENDIX B

HUMAN HEALTH RISK ASSESSMENT SUMMARY TABLES

SMA 5 Soil, 0-1 ft	UCL Statistics for Data Sets with Non-Detects
User Selected Options	
Date/Time of Computation	8/3/2014 8:17:52 PM
From File	SMA 5, Soil 0-1 ft ProUCL input.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benz(a)anthracene

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.26	Mean	0.764
Maximum	1.1	Median	0.89
SD	0.345	Std. Error of Mean	0.154
Coefficient of Variation	0.452	Skewness	-0.835

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.921	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.243	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.093	95% Adjusted-CLT UCL (Chen-1995)	0.956
		95% Modified-t UCL (Johnson-1978)	1.083

Gamma GOF Test

A-D Test Statistic	0.419	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.681	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.287	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.437	k star (bias corrected MLE)	1.908
Theta hat (MLE)	0.172	Theta star (bias corrected MLE)	0.4
nu hat (MLE)	44.37	nu star (bias corrected)	19.08
MLE Mean (bias corrected)	0.764	MLE Sd (bias corrected)	0.553
		Approximate Chi Square Value (0.05)	10.18
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	7.502

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.432	95% Adjusted Gamma UCL (use when n<50)	1.943

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.85	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.275	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.347	Mean of logged Data	-0.386
Maximum of Logged Data	0.0953	SD of logged Data	0.593

Assuming Lognormal Distribution

95% H-UCL	2.134	90% Chebyshev (MVUE) UCL	1.393
95% Chebyshev (MVUE) UCL	1.67	97.5% Chebyshev (MVUE) UCL	2.056
99% Chebyshev (MVUE) UCL	2.812		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.018	95% Jackknife UCL	1.093
95% Standard Bootstrap UCL	0.992	95% Bootstrap-t UCL	1.027
95% Hall's Bootstrap UCL	0.927	95% Percentile Bootstrap UCL	0.996
95% BCA Bootstrap UCL	0.954		
90% Chebyshev(Mean, Sd) UCL	1.227	95% Chebyshev(Mean, Sd) UCL	1.437
97.5% Chebyshev(Mean, Sd) UCL	1.728	99% Chebyshev(Mean, Sd) UCL	2.299

Suggested UCL to Use

95% Student's-t UCL	1.093

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Benzo(a)pyrene

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.37	Mean	0.77
Maximum	1.1	Median	0.88
SD	0.294	Std. Error of Mean	0.132
Coefficient of Variation	0.382	Skewness	-0.5

**Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0**

Normal GOF Test

Shapiro Wilk Test Statistic	0.944	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.246	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.051	95% Adjusted-CLT UCL (Chen-1995)	0.955
		95% Modified-t UCL (Johnson-1978)	1.046

Gamma GOF Test

A-D Test Statistic	0.343	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.288	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.212	k star (bias corrected MLE)	3.018
Theta hat (MLE)	0.107	Theta star (bias corrected MLE)	0.255
nu hat (MLE)	72.12	nu star (bias corrected)	30.18
MLE Mean (bias corrected)	0.77	MLE Sd (bias corrected)	0.443
		Approximate Chi Square Value (0.05)	18.64
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	14.81

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.247	95% Adjusted Gamma UCL (use when n<50)	1.569

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.906	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.278	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.994	Mean of logged Data	-0.332
Maximum of Logged Data	0.0953	SD of logged Data	0.442

Assuming Lognormal Distribution

95% H-UCL	1.46	90% Chebyshev (MVUE) UCL	1.232
95% Chebyshev (MVUE) UCL	1.439	97.5% Chebyshev (MVUE) UCL	1.726
99% Chebyshev (MVUE) UCL	2.29		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.987	95% Jackknife UCL	1.051
95% Standard Bootstrap UCL	0.96	95% Bootstrap-t UCL	1.014
95% Hall's Bootstrap UCL	0.917	95% Percentile Bootstrap UCL	0.954
95% BCA Bootstrap UCL	0.944		

90% Chebyshev(Mean, Sd) UCL	1.165	95% Chebyshev(Mean, Sd) UCL	1.344
97.5% Chebyshev(Mean, Sd) UCL	1.592	99% Chebyshev(Mean, Sd) UCL	2.08

Suggested UCL to Use

95% Student's-t UCL	1.051

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Benzo(b)fluoranthene

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.59	Mean	1.298
Maximum	1.8	Median	1.4
SD	0.473	Std. Error of Mean	0.211
Coefficient of Variation	0.364	Skewness	-0.818

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.957	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.185	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.749	95% Adjusted-CLT UCL (Chen-1995)	1.563
		95% Modified-t UCL (Johnson-1978)	1.736

Gamma GOF Test

A-D Test Statistic	0.336	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.23	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.469	k star (bias corrected MLE)	3.121
Theta hat (MLE)	0.174	Theta star (bias corrected MLE)	0.416
nu hat (MLE)	74.69	nu star (bias corrected)	31.21
MLE Mean (bias corrected)	1.298	MLE Sd (bias corrected)	0.735
		Approximate Chi Square Value (0.05)	19.45

Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	15.53

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.083	95% Adjusted Gamma UCL (use when n<50)	2.609

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.885	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.228	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.528	Mean of logged Data	0.192
Maximum of Logged Data	0.588	SD of logged Data	0.442

Assuming Lognormal Distribution

95% H-UCL	2.466	90% Chebyshev (MVUE) UCL	2.081
95% Chebyshev (MVUE) UCL	2.43	97.5% Chebyshev (MVUE) UCL	2.915
99% Chebyshev (MVUE) UCL	3.868		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.646	95% Jackknife UCL	1.749
95% Standard Bootstrap UCL	1.605	95% Bootstrap-t UCL	1.635
95% Hall's Bootstrap UCL	1.573	95% Percentile Bootstrap UCL	1.6
95% BCA Bootstrap UCL	1.54		
90% Chebyshev(Mean, Sd) UCL	1.932	95% Chebyshev(Mean, Sd) UCL	2.22
97.5% Chebyshev(Mean, Sd) UCL	2.618	99% Chebyshev(Mean, Sd) UCL	3.402

Suggested UCL to Use

95% Student's-t UCL	1.749

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Benzo(k)fluoranthene

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.22	Mean	0.412
Maximum	0.64	Median	0.39
SD	0.159	Std. Error of Mean	0.071
Coefficient of Variation	0.385	Skewness	0.472

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use

guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.988	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.155	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.563	95% Adjusted-CLT UCL (Chen-1995)	0.545
		95% Modified-t UCL (Johnson-1978)	0.566

Gamma GOF Test

A-D Test Statistic	0.161	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.134	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.202	k star (bias corrected MLE)	3.414
Theta hat (MLE)	0.0502	Theta star (bias corrected MLE)	0.121
nu hat (MLE)	82.02	nu star (bias corrected)	34.14
MLE Mean (bias corrected)	0.412	MLE Sd (bias corrected)	0.223
		Approximate Chi Square Value (0.05)	21.78
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	17.59

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.646	95% Adjusted Gamma UCL (use when n<50)	0.799

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.994	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.145	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.514	Mean of logged Data	-0.949
Maximum of Logged Data	-0.446	SD of logged Data	0.401

Assuming Lognormal Distribution

95% H-UCL	0.715	90% Chebyshev (MVUE) UCL	0.633
95% Chebyshev (MVUE) UCL	0.734	97.5% Chebyshev (MVUE) UCL	0.872
99% Chebyshev (MVUE) UCL	1.145		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.529	95% Jackknife UCL	0.563
95% Standard Bootstrap UCL	0.514	95% Bootstrap-t UCL	0.601
95% Hall's Bootstrap UCL	0.728	95% Percentile Bootstrap UCL	0.524
95% BCA Bootstrap UCL	0.526		
90% Chebyshev(Mean, Sd) UCL	0.625	95% Chebyshev(Mean, Sd) UCL	0.721
97.5% Chebyshev(Mean, Sd) UCL	0.855	99% Chebyshev(Mean, Sd) UCL	1.118

Suggested UCL to Use

95% Student's-t UCL	0.563

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Carbazole

General Statistics

Total Number of Observations	5	Number of Distinct Observations	4
Number of Detects	1	Number of Non-Detects	4
Number of Distinct Detects	1	Number of Distinct Non-Detects	3

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Carbazole was not processed!

Chrysene

General Statistics

Total Number of Observations	5	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	0.34	Mean	1.208
Maximum	1.5	Median	1.4
SD	0.492	Std. Error of Mean	0.22
Coefficient of Variation	0.408	Skewness	-2.083

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.692	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.374	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.677	95% Adjusted-CLT UCL (Chen-1995)	1.351
		95% Modified-t UCL (Johnson-1978)	1.643

Gamma GOF Test

A-D Test Statistic	1.02	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.681	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.424	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.358	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.232	k star (bias corrected MLE)	1.826
Theta hat (MLE)	0.285	Theta star (bias corrected MLE)	0.662
nu hat (MLE)	42.32	nu star (bias corrected)	18.26
MLE Mean (bias corrected)	1.208	MLE Sd (bias corrected)	0.894
		Approximate Chi Square Value (0.05)	9.58
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.303	95% Adjusted Gamma UCL (use when n<50)	3.151

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.631	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.42	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.396	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.079	Mean of logged Data	0.0662
Maximum of Logged Data	0.405	SD of logged Data	0.643

Assuming Lognormal Distribution

95% H-UCL	3.973	90% Chebyshev (MVUE) UCL	2.321
95% Chebyshev (MVUE) UCL	2.803	97.5% Chebyshev (MVUE) UCL	3.473
99% Chebyshev (MVUE) UCL	4.789		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.57	95% Jackknife UCL	1.677
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1.868	95% Chebyshev(Mean, Sd) UCL	2.168
97.5% Chebyshev(Mean, Sd) UCL	2.583	99% Chebyshev(Mean, Sd) UCL	3.398

Suggested UCL to Use

95% Student's-t UCL	1.677

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Dibenz(a,h)anthracene

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
Number of Detects	4	Number of Non-Detects	1
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	0.15	Minimum Non-Detect	0.11
Maximum Detect	0.55	Maximum Non-Detect	0.11
Variance Detects	0.0334	Percent Non-Detects	20%
Mean Detects	0.345	SD Detects	0.183
Median Detects	0.34	CV Detects	0.529
Skewness Detects	0.0984	Kurtosis Detects	-3.275
Mean of Logged Detects	-1.186	SD of Logged Detects	0.59

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.217	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.443	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.298	Standard Error of Mean	0.0877
SD	0.17	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.485	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.442	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.561	95% KM Chebyshev UCL	0.68
97.5% KM Chebyshev UCL	0.846	99% KM Chebyshev UCL	1.171

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.278	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.253	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.273	k star (bias corrected MLE)	1.235
Theta hat (MLE)	0.0807	Theta star (bias corrected MLE)	0.279
nu hat (MLE)	34.18	nu star (bias corrected)	9.879
MLE Mean (bias corrected)	0.345	MLE Sd (bias corrected)	0.31

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	3.077	nu hat (KM)	30.77

Approximate Chi Square Value (30.77, α)	19.1	Adjusted Chi Square Value (30.77, β)	15.22
95% Gamma Approximate KM-UCL (use when n>=50)	0.48	95% Gamma Adjusted KM-UCL (use when n<50)	0.602

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.278
Maximum	0.55	Median	0.24
SD	0.218	CV	0.784
k hat (MLE)	0.981	k star (bias corrected MLE)	0.526
Theta hat (MLE)	0.283	Theta star (bias corrected MLE)	0.529
nu hat (MLE)	9.813	nu star (bias corrected)	5.259
MLE Mean (bias corrected)	0.278	MLE Sd (bias corrected)	0.383
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (5.26, α)	1.274	Adjusted Chi Square Value (5.26, β)	0.607
95% Gamma Approximate UCL (use when n>=50)	1.148	95% Gamma Adjusted UCL (use when n<50)	N/A

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.232	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.289	Mean in Log Scale	-1.497
SD in Original Scale	0.202	SD in Log Scale	0.864
95% t UCL (assumes normality of ROS data)	0.481	95% Percentile Bootstrap UCL	0.426
95% BCA Bootstrap UCL	0.422	95% Bootstrap t UCL	0.617
95% H-UCL (Log ROS)	2.105		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-1.39	95% H-UCL (KM -Log)	0.834
KM SD (logged)	0.613	95% Critical H Value (KM-Log)	3.333
KM Standard Error of Mean (logged)	0.316		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.287	Mean in Log Scale	-1.529
SD in Original Scale	0.205	SD in Log Scale	0.921
95% t UCL (Assumes normality)	0.482	95% H-Stat UCL	2.718

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.485	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Indeno(1,2,3-cd)pyrene

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.32	Mean	0.56
Maximum	0.74	Median	0.62
SD	0.172	Std. Error of Mean	0.0767
Coefficient of Variation	0.306	Skewness	-0.641

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.937	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.237	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.724	95% Adjusted-CLT UCL (Chen-1995)	0.663
		95% Modified-t UCL (Johnson-1978)	0.72

Gamma GOF Test

A-D Test Statistic	0.34	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.274	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	11.61	k star (bias corrected MLE)	4.776
Theta hat (MLE)	0.0482	Theta star (bias corrected MLE)	0.117
nu hat (MLE)	116.1	nu star (bias corrected)	47.76
MLE Mean (bias corrected)	0.56	MLE Sd (bias corrected)	0.256
		Approximate Chi Square Value (0.05)	32.9
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	27.62

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.813	95% Adjusted Gamma UCL (use when n<50)	0.968

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.905	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.264	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.139	Mean of logged Data	-0.624
Maximum of Logged Data	-0.301	SD of logged Data	0.343

Assuming Lognormal Distribution

95% H-UCL	0.874	90% Chebyshev (MVUE) UCL	0.819
95% Chebyshev (MVUE) UCL	0.936	97.5% Chebyshev (MVUE) UCL	1.098
99% Chebyshev (MVUE) UCL	1.417		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.686	95% Jackknife UCL	0.724
95% Standard Bootstrap UCL	0.674	95% Bootstrap-t UCL	0.685
95% Hall's Bootstrap UCL	0.643	95% Percentile Bootstrap UCL	0.668
95% BCA Bootstrap UCL	0.664		
90% Chebyshev(Mean, Sd) UCL	0.79	95% Chebyshev(Mean, Sd) UCL	0.895
97.5% Chebyshev(Mean, Sd) UCL	1.039	99% Chebyshev(Mean, Sd) UCL	1.324

Suggested UCL to Use

95% Student's-t UCL	0.724

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Arsenic

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	5.8	Mean	9.42
Maximum	14	Median	9.2
SD	3.241	Std. Error of Mean	1.449
Coefficient of Variation	0.344	Skewness	0.491

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.163	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	12.51	95% Adjusted-CLT UCL (Chen-1995)	12.14
		95% Modified-t UCL (Johnson-1978)	12.56

Gamma GOF Test

A-D Test Statistic	0.185	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.18	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	10.58	k star (bias corrected MLE)	4.364
Theta hat (MLE)	0.891	Theta star (bias corrected MLE)	2.158
nu hat (MLE)	105.8	nu star (bias corrected)	43.64
MLE Mean (bias corrected)	9.42	MLE Sd (bias corrected)	4.509
		Approximate Chi Square Value (0.05)	29.49
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	24.53

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	13.94	95% Adjusted Gamma UCL (use when n<50)	16.76

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.985	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.15	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.758	Mean of logged Data	2.195
Maximum of Logged Data	2.639	SD of logged Data	0.348

Assuming Lognormal Distribution

95% H-UCL	14.79	90% Chebyshev (MVUE) UCL	13.8
95% Chebyshev (MVUE) UCL	15.79	97.5% Chebyshev (MVUE) UCL	18.55
99% Chebyshev (MVUE) UCL	23.96		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	11.8	95% Jackknife UCL	12.51
95% Standard Bootstrap UCL	11.56	95% Bootstrap-t UCL	13.22
95% Hall's Bootstrap UCL	13.13	95% Percentile Bootstrap UCL	11.6
95% BCA Bootstrap UCL	11.84		
90% Chebyshev(Mean, Sd) UCL	13.77	95% Chebyshev(Mean, Sd) UCL	15.74
97.5% Chebyshev(Mean, Sd) UCL	18.47	99% Chebyshev(Mean, Sd) UCL	23.84

Suggested UCL to Use

95% Student's-t UCL	12.51

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Chromium

General Statistics

Total Number of Observations	5	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	15	Mean	22
Maximum	29	Median	23
SD	5.099	Std. Error of Mean	2.28
Coefficient of Variation	0.232	Skewness	-0.0189

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.967	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.222	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	26.86	95% Adjusted-CLT UCL (Chen-1995)	25.73
		95% Modified-t UCL (Johnson-1978)	26.86

Gamma GOF Test

A-D Test Statistic	0.274	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.211	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	22.26	k star (bias corrected MLE)	9.038
Theta hat (MLE)	0.988	Theta star (bias corrected MLE)	2.434
nu hat (MLE)	222.6	nu star (bias corrected)	90.38
MLE Mean (bias corrected)	22	MLE Sd (bias corrected)	7.318
		Approximate Chi Square Value (0.05)	69.46
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	61.48

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	28.63	95% Adjusted Gamma UCL (use when n<50)	32.34

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level

Lilliefors Test Statistic	0.209	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.708	Mean of logged Data	3.068
Maximum of Logged Data	3.367	SD of logged Data	0.242

Assuming Lognormal Distribution

95% H-UCL	29.16	90% Chebyshev (MVUE) UCL	29.14
95% Chebyshev (MVUE) UCL	32.36	97.5% Chebyshev (MVUE) UCL	36.84
99% Chebyshev (MVUE) UCL	45.63		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	25.75	95% Jackknife UCL	26.86
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	28.84	95% Chebyshev(Mean, Sd) UCL	31.94
97.5% Chebyshev(Mean, Sd) UCL	36.24	99% Chebyshev(Mean, Sd) UCL	44.69

Suggested UCL to Use

95% Student's-t UCL	26.86

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

SMA 5 Soil 0-9 ft	UCL Statistics for Data Sets with Non-Detects
User Selected Options	
Date/Time of Computation	8/3/2014 10:50:07 PM
From File	SMA 5, Soil 0-15 ft ProUCL input.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benz(a)anthracene

General Statistics

Total Number of Observations	26	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	0.051	Mean	3.233
Maximum	14	Median	1.45
SD	4.019	Std. Error of Mean	0.788
Coefficient of Variation	1.243	Skewness	1.801

Normal GOF Test

Shapiro Wilk Test Statistic	0.716	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.273	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.174	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.579	95% Adjusted-CLT UCL (Chen-1995)	4.827
		95% Modified-t UCL (Johnson-1978)	4.626

Gamma GOF Test

A-D Test Statistic	0.701	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.781	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.19	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.178	Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.829	k star (bias corrected MLE)	0.759
Theta hat (MLE)	3.9	Theta star (bias corrected MLE)	4.259
nu hat (MLE)	43.11	nu star (bias corrected)	39.47
MLE Mean (bias corrected)	3.233	MLE Sd (bias corrected)	3.711
		Approximate Chi Square Value (0.05)	26.08
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	25.36

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	4.893	95% Adjusted Gamma UCL (use when n<50)	5.032

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.113	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.174	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.976	Mean of logged Data	0.461
Maximum of Logged Data	2.639	SD of logged Data	1.314

Assuming Lognormal Distribution

95% H-UCL	8.138	90% Chebyshev (MVUE) UCL	6.86
95% Chebyshev (MVUE) UCL	8.358	97.5% Chebyshev (MVUE) UCL	10.44
99% Chebyshev (MVUE) UCL	14.52		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.529	95% Jackknife UCL	4.579
95% Standard Bootstrap UCL	4.512	95% Bootstrap-t UCL	5.121
95% Hall's Bootstrap UCL	4.632	95% Percentile Bootstrap UCL	4.53
95% BCA Bootstrap UCL	4.832		
90% Chebyshev(Mean, Sd) UCL	5.597	95% Chebyshev(Mean, Sd) UCL	6.668
97.5% Chebyshev(Mean, Sd) UCL	8.155	99% Chebyshev(Mean, Sd) UCL	11.07

Suggested UCL to Use

95% Adjusted Gamma UCL	5.032

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Benzo(a)pyrene

General Statistics

Total Number of Observations	26	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	0.04	Mean	4.079
Maximum	26	Median	1.4
SD	5.75	Std. Error of Mean	1.128
Coefficient of Variation	1.41	Skewness	2.559

Normal GOF Test

Shapiro Wilk Test Statistic	0.674	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.269	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.174	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	6.005	95% Adjusted-CLT UCL (Chen-1995)	6.538
		95% Modified-t UCL (Johnson-1978)	6.099

Gamma GOF Test

A-D Test Statistic	0.838	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.787	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.193	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.178	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.72	k star (bias corrected MLE)	0.662
Theta hat (MLE)	5.667	Theta star (bias corrected MLE)	6.158
nu hat (MLE)	37.43	nu star (bias corrected)	34.44
MLE Mean (bias corrected)	4.079	MLE Sd (bias corrected)	5.012
		Approximate Chi Square Value (0.05)	22.02
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	21.36

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	6.38	95% Adjusted Gamma UCL (use when n<50)	6.577

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.961	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.123	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.174	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-3.219	Mean of logged Data	0.569
Maximum of Logged Data	3.258	SD of logged Data	1.425

Assuming Lognormal Distribution

95% H-UCL	11.82	90% Chebyshev (MVUE) UCL	9.218
95% Chebyshev (MVUE) UCL	11.34	97.5% Chebyshev (MVUE) UCL	14.27
99% Chebyshev (MVUE) UCL	20.05		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5.934	95% Jackknife UCL	6.005
95% Standard Bootstrap UCL	5.913	95% Bootstrap-t UCL	7.109
95% Hall's Bootstrap UCL	12.04	95% Percentile Bootstrap UCL	6.038
95% BCA Bootstrap UCL	6.72		
90% Chebyshev(Mean, Sd) UCL	7.462	95% Chebyshev(Mean, Sd) UCL	8.994
97.5% Chebyshev(Mean, Sd) UCL	11.12	99% Chebyshev(Mean, Sd) UCL	15.3

Suggested UCL to Use

95% H-UCL	11.82

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Benzo(b)fluoranthene

General Statistics

Total Number of Observations	26	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	0.062	Mean	6.568
Maximum	43	Median	2.55

SD	9.226	Std. Error of Mean	1.809
Coefficient of Variation	1.405	Skewness	2.771

Normal GOF Test

Shapiro Wilk Test Statistic	0.662	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.92	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.266	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.174	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	9.659	95% Adjusted-CLT UCL (Chen-1995)	10.59
		95% Modified-t UCL (Johnson-1978)	9.823

Gamma GOF Test

A-D Test Statistic	0.741	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.784	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.194	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.178	Data Not Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.754	k star (bias corrected MLE)	0.693
Theta hat (MLE)	8.711	Theta star (bias corrected MLE)	9.482
nu hat (MLE)	39.21	nu star (bias corrected)	36.02
MLE Mean (bias corrected)	6.568	MLE Sd (bias corrected)	7.892
		Approximate Chi Square Value (0.05)	23.28
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	22.61

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	10.16	95% Adjusted Gamma UCL (use when n<50)	10.46

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.123	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.174	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.781	Mean of logged Data	1.089
Maximum of Logged Data	3.761	SD of logged Data	1.397

Assuming Lognormal Distribution

95% H-UCL	18.55	90% Chebyshev (MVUE) UCL	14.77
95% Chebyshev (MVUE) UCL	18.12	97.5% Chebyshev (MVUE) UCL	22.77
99% Chebyshev (MVUE) UCL	31.9		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	9.544	95% Jackknife UCL	9.659
95% Standard Bootstrap UCL	9.45	95% Bootstrap-t UCL	11.84
95% Hall's Bootstrap UCL	21.17	95% Percentile Bootstrap UCL	9.552

95% BCA Bootstrap UCL	11.04		
90% Chebyshev(Mean, Sd) UCL	12	95% Chebyshev(Mean, Sd) UCL	14.45
97.5% Chebyshev(Mean, Sd) UCL	17.87	99% Chebyshev(Mean, Sd) UCL	24.57

Suggested UCL to Use

95% Adjusted Gamma UCL	10.46

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Benzo(k)fluoranthene

General Statistics

Total Number of Observations	26	Number of Distinct Observations	23
		Number of Missing Observations	0
Minimum	0.02	Mean	2.249
Maximum	14	Median	0.895
SD	3.087	Std. Error of Mean	0.605
Coefficient of Variation	1.372	Skewness	2.544

Normal GOF Test

Shapiro Wilk Test Statistic	0.684	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.261	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.174	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.283	95% Adjusted-CLT UCL (Chen-1995)	3.568
		95% Modified-t UCL (Johnson-1978)	3.334

Gamma GOF Test

A-D Test Statistic	0.685	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.785	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.174	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.178	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.746	k star (bias corrected MLE)	0.686
Theta hat (MLE)	3.015	Theta star (bias corrected MLE)	3.281
nu hat (MLE)	38.79	nu star (bias corrected)	35.65
MLE Mean (bias corrected)	2.249	MLE Sd (bias corrected)	2.716
		Approximate Chi Square Value (0.05)	22.99
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	22.32

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	3.488	95% Adjusted Gamma UCL (use when n<50)	3.593

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0997	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.174	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-3.912	Mean of logged Data	0.00761
Maximum of Logged Data	2.639	SD of logged Data	1.415

Assuming Lognormal Distribution

95% H-UCL	6.568	90% Chebyshev (MVUE) UCL	5.162
95% Chebyshev (MVUE) UCL	6.342	97.5% Chebyshev (MVUE) UCL	7.98
99% Chebyshev (MVUE) UCL	11.2		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.245	95% Jackknife UCL	3.283
95% Standard Bootstrap UCL	3.235	95% Bootstrap-t UCL	3.965
95% Hall's Bootstrap UCL	4.897	95% Percentile Bootstrap UCL	3.325
95% BCA Bootstrap UCL	3.761		
90% Chebyshev(Mean, Sd) UCL	4.065	95% Chebyshev(Mean, Sd) UCL	4.888
97.5% Chebyshev(Mean, Sd) UCL	6.03	99% Chebyshev(Mean, Sd) UCL	8.273

Suggested UCL to Use

95% Adjusted Gamma UCL	3.593

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Carbazole

General Statistics

Total Number of Observations	26	Number of Distinct Observations	22
Number of Detects	18	Number of Non-Detects	8
Number of Distinct Detects	17	Number of Distinct Non-Detects	6
Minimum Detect	0.043	Minimum Non-Detect	0.039
Maximum Detect	6.3	Maximum Non-Detect	0.22
Variance Detects	2.073	Percent Non-Detects	30.77%
Mean Detects	0.687	SD Detects	1.44
Median Detects	0.265	CV Detects	2.095
Skewness Detects	3.886	Kurtosis Detects	15.77
Mean of Logged Detects	-1.306	SD of Logged Detects	1.292

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.438	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.357	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.209	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.495	Standard Error of Mean	0.242
SD	1.2	95% KM (BCA) UCL	0.97
95% KM (t) UCL	0.909	95% KM (Percentile Bootstrap) UCL	0.949
95% KM (z) UCL	0.893	95% KM Bootstrap t UCL	2.049
90% KM Chebyshev UCL	1.221	95% KM Chebyshev UCL	1.55

97.5% KM Chebyshev UCL	2.007	99% KM Chebyshev UCL	2.904

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.06	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.786	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.229	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.213	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.655	k star (bias corrected MLE)	0.583
Theta hat (MLE)	1.048	Theta star (bias corrected MLE)	1.178
nu hat (MLE)	23.6	nu star (bias corrected)	21
MLE Mean (bias corrected)	0.687	MLE Sd (bias corrected)	0.9

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.17	nu hat (KM)	8.857
Approximate Chi Square Value (8.86, α)	3.241	Adjusted Chi Square Value (8.86, β)	3.019
95% Gamma Approximate KM-UCL (use when n>=50)	1.353	95% Gamma Adjusted KM-UCL (use when n<50)	1.452

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.479
Maximum	6.3	Median	0.135
SD	1.229	CV	2.567
k hat (MLE)	0.413	k star (bias corrected MLE)	0.391
Theta hat (MLE)	1.159	Theta star (bias corrected MLE)	1.224
nu hat (MLE)	21.48	nu star (bias corrected)	20.34
MLE Mean (bias corrected)	0.479	MLE Sd (bias corrected)	0.766
		Adjusted Level of Significance (β)	0.0398
Approximate Chi Square Value (20.34, α)	11.1	Adjusted Chi Square Value (20.34, β)	10.65
95% Gamma Approximate UCL (use when n>=50)	0.877	95% Gamma Adjusted UCL (use when n<50)	0.914

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.119	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.209	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.489	Mean in Log Scale	-1.927
SD in Original Scale	1.225	SD in Log Scale	1.482
95% t UCL (assumes normality of ROS data)	0.9	95% Percentile Bootstrap UCL	0.938
95% BCA Bootstrap UCL	1.176	95% Bootstrap t UCL	2.059
95% H-UCL (Log ROS)	1.125		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-1.797	95% H-UCL (KM -Log)	0.833
KM SD (logged)	1.305	95% Critical H Value (KM-Log)	2.925
KM Standard Error of Mean (logged)	0.271		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.5	Mean in Log Scale	-1.731
SD in Original Scale	1.221	SD in Log Scale	1.305
95% t UCL (Assumes normality)	0.91	95% H-Stat UCL	0.89

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	2.007

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chrysene

General Statistics

Total Number of Observations	26	Number of Distinct Observations	25
		Number of Missing Observations	0
Minimum	0.056	Mean	4.194
Maximum	20	Median	1.9
SD	4.97	Std. Error of Mean	0.975
Coefficient of Variation	1.185	Skewness	1.916

Normal GOF Test

Shapiro Wilk Test Statistic	0.746	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.92	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.249	Lilliefors GOF Test
5% Lilliefors Critical Value	0.174	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.859	95% Adjusted-CLT UCL (Chen-1995)	6.188
		95% Modified-t UCL (Johnson-1978)	5.92

Gamma GOF Test

A-D Test Statistic	0.575	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.778	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.149	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.177	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.897	k star (bias corrected MLE)	0.819
Theta hat (MLE)	4.673	Theta star (bias corrected MLE)	5.118
nu hat (MLE)	46.66	nu star (bias corrected)	42.61
MLE Mean (bias corrected)	4.194	MLE Sd (bias corrected)	4.633
		Approximate Chi Square Value (0.05)	28.65
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	27.89

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	6.238	95% Adjusted Gamma UCL (use when n<50)	6.408

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.956	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.112	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.174	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.882	Mean of logged Data	0.782
Maximum of Logged Data	2.996	SD of logged Data	1.285

Assuming Lognormal Distribution

95% H-UCL	10.51	90% Chebyshev (MVUE) UCL	9.018
95% Chebyshev (MVUE) UCL	10.96	97.5% Chebyshev (MVUE) UCL	13.66
99% Chebyshev (MVUE) UCL	18.95		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5.797	95% Jackknife UCL	5.859
95% Standard Bootstrap UCL	5.778	95% Bootstrap-t UCL	6.535
95% Hall's Bootstrap UCL	6.602	95% Percentile Bootstrap UCL	5.847
95% BCA Bootstrap UCL	6.101		
90% Chebyshev(Mean, Sd) UCL	7.118	95% Chebyshev(Mean, Sd) UCL	8.442
97.5% Chebyshev(Mean, Sd) UCL	10.28	99% Chebyshev(Mean, Sd) UCL	13.89

Suggested UCL to Use

95% Adjusted Gamma UCL	6.408

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Dibenz(a,h)anthracene

General Statistics

Total Number of Observations	26	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	0.0095	Mean	1.073
Maximum	7.9	Median	0.38
SD	1.632	Std. Error of Mean	0.32
Coefficient of Variation	1.52	Skewness	3.216

Normal GOF Test

Shapiro Wilk Test Statistic	0.609	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.92	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.264	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.174	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.62	95% Adjusted-CLT UCL (Chen-1995)	1.815
		95% Modified-t UCL (Johnson-1978)	1.653

Gamma GOF Test

A-D Test Statistic	0.873	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.785	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.212	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.178	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.74	k star (bias corrected MLE)	0.68
Theta hat (MLE)	1.45	Theta star (bias corrected MLE)	1.577
nu hat (MLE)	38.49	nu star (bias corrected)	35.38
MLE Mean (bias corrected)	1.073	MLE Sd (bias corrected)	1.301
		Approximate Chi Square Value (0.05)	22.77
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	22.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.668	95% Adjusted Gamma UCL (use when n<50)	1.718

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.132	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.174	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-4.656	Mean of logged Data	-0.74
Maximum of Logged Data	2.067	SD of logged Data	1.387

Assuming Lognormal Distribution

95% H-UCL	2.905	90% Chebyshev (MVUE) UCL	2.331
95% Chebyshev (MVUE) UCL	2.857	97.5% Chebyshev (MVUE) UCL	3.588
99% Chebyshev (MVUE) UCL	5.024		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.6	95% Jackknife UCL	1.62
95% Standard Bootstrap UCL	1.571	95% Bootstrap-t UCL	2.084
95% Hall's Bootstrap UCL	3.666	95% Percentile Bootstrap UCL	1.628
95% BCA Bootstrap UCL	1.92		
90% Chebyshev(Mean, Sd) UCL	2.033	95% Chebyshev(Mean, Sd) UCL	2.468
97.5% Chebyshev(Mean, Sd) UCL	3.071	99% Chebyshev(Mean, Sd) UCL	4.257

Suggested UCL to Use

95% H-UCL	2.905

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Indeno(1,2,3-cd)pyrene

General Statistics

Total Number of Observations	26	Number of Distinct Observations	25
		Number of Missing Observations	0
Minimum	0.03	Mean	3.324
Maximum	24	Median	0.98
SD	5.18	Std. Error of Mean	1.016
Coefficient of Variation	1.558	Skewness	2.924

Normal GOF Test

Shapiro Wilk Test Statistic	0.627	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.284	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.174	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	5.059	95% Adjusted-CLT UCL (Chen-1995)	5.617
		95% Modified-t UCL (Johnson-1978)	5.156

Gamma GOF Test

A-D Test Statistic	0.952	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.792	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.195	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.179	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.666	k star (bias corrected MLE)	0.615
Theta hat (MLE)	4.992	Theta star (bias corrected MLE)	5.408
nu hat (MLE)	34.62	nu star (bias corrected)	31.96
MLE Mean (bias corrected)	3.324	MLE Sd (bias corrected)	4.24
		Approximate Chi Square Value (0.05)	20.04
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	19.42

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5.301	95% Adjusted Gamma UCL (use when n<50)	5.472

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.963	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.118	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.174	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-3.507	Mean of logged Data	0.287
Maximum of Logged Data	3.178	SD of logged Data	1.462

Assuming Lognormal Distribution

95% H-UCL	9.764	90% Chebyshev (MVUE) UCL	7.4
95% Chebyshev (MVUE) UCL	9.126	97.5% Chebyshev (MVUE) UCL	11.52
99% Chebyshev (MVUE) UCL	16.22		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.995	95% Jackknife UCL	5.059
95% Standard Bootstrap UCL	4.949	95% Bootstrap-t UCL	6.487
95% Hall's Bootstrap UCL	12.09	95% Percentile Bootstrap UCL	5.179
95% BCA Bootstrap UCL	5.646		
90% Chebyshev(Mean, Sd) UCL	6.372	95% Chebyshev(Mean, Sd) UCL	7.752
97.5% Chebyshev(Mean, Sd) UCL	9.668	99% Chebyshev(Mean, Sd) UCL	13.43

Suggested UCL to Use

95% H-UCL	9.764

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Naphthalene

General Statistics

Total Number of Observations	26	Number of Distinct Observations	25
Number of Detects	25	Number of Non-Detects	1
Number of Distinct Detects	24	Number of Distinct Non-Detects	1
Minimum Detect	0.098	Minimum Non-Detect	0.029
Maximum Detect	210	Maximum Non-Detect	0.029
Variance Detects	1743	Percent Non-Detects	3.846%
Mean Detects	9.776	SD Detects	41.75
Median Detects	0.71	CV Detects	4.271
Skewness Detects	4.986	Kurtosis Detects	24.9
Mean of Logged Detects	0.0545	SD of Logged Detects	1.489

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.232	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.487	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.177	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	9.401	Standard Error of Mean	8.037
SD	40.15	95% KM (BCA) UCL	25.44
95% KM (t) UCL	23.13	95% KM (Percentile Bootstrap) UCL	25.27
95% KM (z) UCL	22.62	95% KM Bootstrap t UCL	289.2
90% KM Chebyshev UCL	33.51	95% KM Chebyshev UCL	44.43
97.5% KM Chebyshev UCL	59.59	99% KM Chebyshev UCL	89.37

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.797	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.85	Detected Data Not Gamma Distributed at 5% Significance Level

K-S Test Statistic	0.333	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.189	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.308	k star (bias corrected MLE)	0.298
Theta hat (MLE)	31.69	Theta star (bias corrected MLE)	32.79
nu hat (MLE)	15.42	nu star (bias corrected)	14.91
MLE Mean (bias corrected)	9.776	MLE Sd (bias corrected)	17.9

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.0548	nu hat (KM)	2.85
Approximate Chi Square Value (2.85, α)	0.329	Adjusted Chi Square Value (2.85, β)	0.285
95% Gamma Approximate KM-UCL (use when n>=50)	81.33	95% Gamma Adjusted KM-UCL (use when n<50)	93.92

Gamma (KM) may not be used when k hat (KM) is < 0.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	9.4
Maximum	210	Median	0.7
SD	40.95	CV	4.356
k hat (MLE)	0.293	k star (bias corrected MLE)	0.285
Theta hat (MLE)	32.12	Theta star (bias corrected MLE)	33.03
nu hat (MLE)	15.22	nu star (bias corrected)	14.8
MLE Mean (bias corrected)	9.4	MLE Sd (bias corrected)	17.62
		Adjusted Level of Significance (β)	0.0398
Approximate Chi Square Value (14.80, α)	7.121	Adjusted Chi Square Value (14.80, β)	6.77
95% Gamma Approximate UCL (use when n>=50)	19.53	95% Gamma Adjusted UCL (use when n<50)	20.55

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.85	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.167	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.177	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	9.401	Mean in Log Scale	-0.0771
SD in Original Scale	40.95	SD in Log Scale	1.605
95% t UCL (assumes normality of ROS data)	23.12	95% Percentile Bootstrap UCL	25.13
95% BCA Bootstrap UCL	33.67	95% Bootstrap t UCL	306.5
95% H-UCL (Log ROS)	9.939		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-0.0838	95% H-UCL (KM -Log)	9.423
KM SD (logged)	1.589	95% Critical H Value (KM-Log)	3.352
KM Standard Error of Mean (logged)	0.318		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	9.4	Mean in Log Scale	-0.11
SD in Original Scale	40.95	SD in Log Scale	1.684
95% t UCL (Assumes normality)	23.12	95% H-Stat UCL	12.01

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	59.59

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic

General Statistics

Total Number of Observations	26	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	2	Mean	11.64
Maximum	25	Median	10
SD	6.429	Std. Error of Mean	1.261
Coefficient of Variation	0.552	Skewness	0.575

Normal GOF Test

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.139	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.174	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	13.79	95% Adjusted-CLT UCL (Chen-1995)	13.86
		95% Modified-t UCL (Johnson-1978)	13.82

Gamma GOF Test

A-D Test Statistic	0.225	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0903	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.172	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.036	k star (bias corrected MLE)	2.711
Theta hat (MLE)	3.833	Theta star (bias corrected MLE)	4.292
nu hat (MLE)	157.9	nu star (bias corrected)	141
MLE Mean (bias corrected)	11.64	MLE Sd (bias corrected)	7.068
		Approximate Chi Square Value (0.05)	114.6
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	113

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	14.32	95% Adjusted Gamma UCL (use when n<50)	14.52

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.129	**Lilliefors Lognormal GOF Test**

5% Lilliefors Critical Value	0.174	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.693	Mean of logged Data	2.281
Maximum of Logged Data	3.219	SD of logged Data	0.645

Assuming Lognormal Distribution

95% H-UCL	15.78	90% Chebyshev (MVUE) UCL	16.76
95% Chebyshev (MVUE) UCL	18.94	97.5% Chebyshev (MVUE) UCL	21.98
99% Chebyshev (MVUE) UCL	27.93		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	13.71	95% Jackknife UCL	13.79
95% Standard Bootstrap UCL	13.73	95% Bootstrap-t UCL	13.96
95% Hall's Bootstrap UCL	14	95% Percentile Bootstrap UCL	13.62
95% BCA Bootstrap UCL	13.78		
90% Chebyshev(Mean, Sd) UCL	15.42	95% Chebyshev(Mean, Sd) UCL	17.13
97.5% Chebyshev(Mean, Sd) UCL	19.51	99% Chebyshev(Mean, Sd) UCL	24.18

Suggested UCL to Use

95% Student's-t UCL	13.79

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Chromium

General Statistics

Total Number of Observations	26	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	7.1	Mean	31.98
Maximum	88	Median	25.5
SD	19.58	Std. Error of Mean	3.841
Coefficient of Variation	0.612	Skewness	1.595

Normal GOF Test

Shapiro Wilk Test Statistic	0.829	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.251	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.174	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	38.54	95% Adjusted-CLT UCL (Chen-1995)	39.59
		95% Modified-t UCL (Johnson-1978)	38.74

Gamma GOF Test

A-D Test Statistic	0.765	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.75	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.179	**Kolmogrov-Smirnoff Gamma GOF Test**

5% K-S Critical Value	0.172	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.271	k star (bias corrected MLE)	2.919
Theta hat (MLE)	9.779	Theta star (bias corrected MLE)	10.96
nu hat (MLE)	170.1	nu star (bias corrected)	151.8
MLE Mean (bias corrected)	31.98	MLE Sd (bias corrected)	18.72
		Approximate Chi Square Value (0.05)	124.3
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	122.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	39.05	95% Adjusted Gamma UCL (use when n<50)	39.58

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.154	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.174	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.96	Mean of logged Data	3.305
Maximum of Logged Data	4.477	SD of logged Data	0.586

Assuming Lognormal Distribution

95% H-UCL	41.08	90% Chebyshev (MVUE) UCL	43.78
95% Chebyshev (MVUE) UCL	49.07	97.5% Chebyshev (MVUE) UCL	56.42
99% Chebyshev (MVUE) UCL	70.84		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	38.3	95% Jackknife UCL	38.54
95% Standard Bootstrap UCL	38.18	95% Bootstrap-t UCL	40.98
95% Hall's Bootstrap UCL	42.08	95% Percentile Bootstrap UCL	38.75
95% BCA Bootstrap UCL	39.54		
90% Chebyshev(Mean, Sd) UCL	43.51	95% Chebyshev(Mean, Sd) UCL	48.73
97.5% Chebyshev(Mean, Sd) UCL	55.97	99% Chebyshev(Mean, Sd) UCL	70.2

Suggested UCL to Use

95% H-UCL	41.08

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Lead

General Statistics

Total Number of Observations	26	Number of Distinct Observations	25
		Number of Missing Observations	0
Minimum	3.4	Mean	96.24
Maximum	820	Median	33
SD	165.7	Std. Error of Mean	32.49
Coefficient of Variation	1.721	Skewness	3.665

Normal GOF Test

Shapiro Wilk Test Statistic	0.541	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.288	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.174	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	151.7	95% Adjusted-CLT UCL (Chen-1995)	174.6
		95% Modified-t UCL (Johnson-1978)	155.6

Gamma GOF Test

A-D Test Statistic	0.981	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.785	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.178	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.178	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.739	k star (bias corrected MLE)	0.68
Theta hat (MLE)	130.2	Theta star (bias corrected MLE)	141.6
nu hat (MLE)	38.44	nu star (bias corrected)	35.34
MLE Mean (bias corrected)	96.24	MLE Sd (bias corrected)	116.7
		Approximate Chi Square Value (0.05)	22.74
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	22.07

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	149.6	95% Adjusted Gamma UCL (use when n<50)	154.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.985	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.111	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.174	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.224	Mean of logged Data	3.756
Maximum of Logged Data	6.709	SD of logged Data	1.262

Assuming Lognormal Distribution

95% H-UCL	195.3	90% Chebyshev (MVUE) UCL	170
95% Chebyshev (MVUE) UCL	206.1	97.5% Chebyshev (MVUE) UCL	256.4
99% Chebyshev (MVUE) UCL	355		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	149.7	95% Jackknife UCL	151.7
95% Standard Bootstrap UCL	147.9	95% Bootstrap-t UCL	219.1
95% Hall's Bootstrap UCL	349.1	95% Percentile Bootstrap UCL	149.9
95% BCA Bootstrap UCL	180.7		
90% Chebyshev(Mean, Sd) UCL	193.7	95% Chebyshev(Mean, Sd) UCL	237.8
97.5% Chebyshev(Mean, Sd) UCL	299.1	99% Chebyshev(Mean, Sd) UCL	419.5

Suggested UCL to Use

95% Adjusted Gamma UCL 154.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Mercury

General Statistics

Total Number of Observations	26	Number of Distinct Observations	24
Number of Detects	25	Number of Non-Detects	1
Number of Distinct Detects	23	Number of Distinct Non-Detects	1
Minimum Detect	0.03	Minimum Non-Detect	0.008
Maximum Detect	5	Maximum Non-Detect	0.008
Variance Detects	1.869	Percent Non-Detects	3.846%
Mean Detects	0.899	SD Detects	1.367
Median Detects	0.31	CV Detects	1.52
Skewness Detects	2.237	Kurtosis Detects	4.203
Mean of Logged Detects	-0.96	SD of Logged Detects	1.327

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.623	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.335	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.177	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.865	Standard Error of Mean	0.265
SD	1.324	95% KM (BCA) UCL	1.319
95% KM (t) UCL	1.318	95% KM (Percentile Bootstrap) UCL	1.301
95% KM (z) UCL	1.301	95% KM Bootstrap t UCL	1.571
90% KM Chebyshev UCL	1.66	95% KM Chebyshev UCL	2.021
97.5% KM Chebyshev UCL	2.521	99% KM Chebyshev UCL	3.503

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.164	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.788	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.198	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.182	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.707	k star (bias corrected MLE)	0.648
Theta hat (MLE)	1.273	Theta star (bias corrected MLE)	1.387
nu hat (MLE)	35.33	nu star (bias corrected)	32.42
MLE Mean (bias corrected)	0.899	MLE Sd (bias corrected)	1.117

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.427	nu hat (KM)	22.18
Approximate Chi Square Value (22.18, α)	12.48	Adjusted Chi Square Value (22.18, β)	11.99
95% Gamma Approximate KM-UCL (use when n>=50)	1.538	95% Gamma Adjusted KM-UCL (use when n<50)	1.6

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.865
Maximum	5	Median	0.3
SD	1.351	CV	1.561
k hat (MLE)	0.64	k star (bias corrected MLE)	0.592
Theta hat (MLE)	1.351	Theta star (bias corrected MLE)	1.461
nu hat (MLE)	33.3	nu star (bias corrected)	30.79
MLE Mean (bias corrected)	0.865	MLE Sd (bias corrected)	1.124
		Adjusted Level of Significance (β)	0.0398
Approximate Chi Square Value (30.79, α)	19.12	Adjusted Chi Square Value (30.79, β)	18.51
95% Gamma Approximate UCL (use when n>=50)	1.394	95% Gamma Adjusted UCL (use when n<50)	1.439

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.967	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.118	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.177	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.865	Mean in Log Scale	-1.087
SD in Original Scale	1.351	SD in Log Scale	1.453
95% t UCL (assumes normality of ROS data)	1.318	95% Percentile Bootstrap UCL	1.32
95% BCA Bootstrap UCL	1.408	95% Bootstrap t UCL	1.637
95% H-UCL (Log ROS)	2.416		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-1.109	95% H-UCL (KM -Log)	2.507
KM SD (logged)	1.476	95% Critical H Value (KM-Log)	3.18
KM Standard Error of Mean (logged)	0.295		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.865	Mean in Log Scale	-1.136
SD in Original Scale	1.351	SD in Log Scale	1.578
95% t UCL (Assumes normality)	1.317	95% H-Stat UCL	3.198

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	2.521

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	9/17/2015 12:02:50 PM
From File	RSL data, ProUCL input.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

1,2,3-Trichlorobenzene

General Statistics

Total Number of Observations	26	Number of Distinct Observations	18
Number of Detects	1	Number of Non-Detects	25
Number of Distinct Detects	1	Number of Distinct Non-Detects	17

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 1,2,3-Trichlorobenzene was not processed!

Benzene

General Statistics

Total Number of Observations	26	Number of Distinct Observations	20
Number of Detects	6	Number of Non-Detects	20
Number of Distinct Detects	6	Number of Distinct Non-Detects	14
Minimum Detect	7.9000E-4	Minimum Non-Detect	4.6000E-4
Maximum Detect	0.35	Maximum Non-Detect	7.7000E-4
Variance Detects	0.0202	Percent Non-Detects	76.92%
Mean Detects	0.0599	SD Detects	0.142
Median Detects	0.00125	CV Detects	2.37
Skewness Detects	2.449	Kurtosis Detects	5.997
Mean of Logged Detects	-5.616	SD of Logged Detects	2.337

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.505	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.483	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0142	Standard Error of Mean	0.0144
SD	0.0672	95% KM (BCA) UCL	0.0411
95% KM (t) UCL	0.0388	95% KM (Percentile Bootstrap) UCL	0.041
95% KM (z) UCL	0.0379	95% KM Bootstrap t UCL	3.386
90% KM Chebyshev UCL	0.0575	95% KM Chebyshev UCL	0.0771
97.5% KM Chebyshev UCL	0.104	99% KM Chebyshev UCL	0.158

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.244	**Anderson-Darling GOF Test**

5% A-D Critical Value	0.783	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.411	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.36	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.253	k star (bias corrected MLE)	0.238
Theta hat (MLE)	0.237	Theta star (bias corrected MLE)	0.252
nu hat (MLE)	3.037	nu star (bias corrected)	2.852
MLE Mean (bias corrected)	0.0599	MLE Sd (bias corrected)	0.123

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.0446	nu hat (KM)	2.32
Approximate Chi Square Value (2.32, α)	0.203	Adjusted Chi Square Value (2.32, β)	0.177
95% Gamma Approximate KM-UCL (use when n>=50)	0.162	95% Gamma Adjusted KM-UCL (use when n<50)	0.186

Gamma (KM) may not be used when k hat (KM) is < 0.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	7.9000E-4	Mean	0.0215
Maximum	0.35	Median	0.01
SD	0.0671	CV	3.116
k hat (MLE)	0.616	k star (bias corrected MLE)	0.57
Theta hat (MLE)	0.035	Theta star (bias corrected MLE)	0.0378
nu hat (MLE)	32.01	nu star (bias corrected)	29.65
MLE Mean (bias corrected)	0.0215	MLE Sd (bias corrected)	0.0285
		Adjusted Level of Significance (β)	0.0398
Approximate Chi Square Value (29.65, α)	18.22	Adjusted Chi Square Value (29.65, β)	17.63
95% Gamma Approximate UCL (use when n>=50)	0.035	95% Gamma Adjusted UCL (use when n<50)	0.0362

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.709	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.337	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0138	Mean in Log Scale	-12.6
SD in Original Scale	0.0686	SD in Log Scale	4.285
95% t UCL (assumes normality of ROS data)	0.0368	95% Percentile Bootstrap UCL	0.0406
95% BCA Bootstrap UCL	0.0544	95% Bootstrap t UCL	2.412
95% H-UCL (Log ROS)	29.7		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-7.207	95% H-UCL (KM -Log)	0.00409
KM SD (logged)	1.345	95% Critical H Value (KM-Log)	2.984
KM Standard Error of Mean (logged)	0.289		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0141	Mean in Log Scale	-7.566
SD in Original Scale	0.0685	SD in Log Scale	1.515

95% t UCL (Assumes normality)	0.037	95% H-Stat UCL	0.00435

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

99% KM (Chebyshev) UCL 0.158

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Isopropylbenzene

General Statistics

Total Number of Observations	26	Number of Distinct Observations	19
Number of Detects	1	Number of Non-Detects	25
Number of Distinct Detects	1	Number of Distinct Non-Detects	18

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Isopropylbenzene was not processed!

Methylene chloride

General Statistics

Total Number of Observations	26	Number of Distinct Observations	16
Number of Detects	11	Number of Non-Detects	15
Number of Distinct Detects	9	Number of Distinct Non-Detects	8
Minimum Detect	0.0018	Minimum Non-Detect	0.0016
Maximum Detect	0.0062	Maximum Non-Detect	0.084
Variance Detects	2.3765E-6	Percent Non-Detects	57.69%
Mean Detects	0.00386	SD Detects	0.00154
Median Detects	0.0033	CV Detects	0.399
Skewness Detects	0.197	Kurtosis Detects	-1.698
Mean of Logged Detects	-5.634	SD of Logged Detects	0.421

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.901	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.209	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.267	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00261	Standard Error of Mean	3.1079E-4
SD	0.00148	95% KM (BCA) UCL	0.00314
95% KM (t) UCL	0.00314	95% KM (Percentile Bootstrap) UCL	0.00315
95% KM (z) UCL	0.00312	95% KM Bootstrap t UCL	0.0033
90% KM Chebyshev UCL	0.00354	95% KM Chebyshev UCL	0.00396
97.5% KM Chebyshev UCL	0.00455	99% KM Chebyshev UCL	0.0057

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.516	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.731	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.201	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.256	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	6.6	k star (bias corrected MLE)	4.861
Theta hat (MLE)	5.8536E-4	Theta star (bias corrected MLE)	7.9484E-4
nu hat (MLE)	145.2	nu star (bias corrected)	106.9
MLE Mean (bias corrected)	0.00386	MLE Sd (bias corrected)	0.00175

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	3.11	nu hat (KM)	161.7
Approximate Chi Square Value (161.73, α)	133.3	Adjusted Chi Square Value (161.73, β)	131.6
95% Gamma Approximate KM-UCL (use when n>=50)	0.00317	95% Gamma Adjusted KM-UCL (use when n<50)	0.00321

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0018	Mean	0.0074
Maximum	0.01	Median	0.01
SD	0.00324	CV	0.438
k hat (MLE)	3.873	k star (bias corrected MLE)	3.452
Theta hat (MLE)	0.00191	Theta star (bias corrected MLE)	0.00214
nu hat (MLE)	201.4	nu star (bias corrected)	179.5
MLE Mean (bias corrected)	0.0074	MLE Sd (bias corrected)	0.00398
		Adjusted Level of Significance (β)	0.0398
Approximate Chi Square Value (179.51, α)	149.5	Adjusted Chi Square Value (179.51, β)	147.7
95% Gamma Approximate UCL (use when n>=50)	0.00889	95% Gamma Adjusted UCL (use when n<50)	0.009

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.916	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.189	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.267	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00233	Mean in Log Scale	-6.278
SD in Original Scale	0.00167	SD in Log Scale	0.658
95% t UCL (assumes normality of ROS data)	0.0029	95% Percentile Bootstrap UCL	0.00288
95% BCA Bootstrap UCL	0.00295	95% Bootstrap t UCL	0.00301
95% H-UCL (Log ROS)	0.00308		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-6.076	95% H-UCL (KM -Log)	0.00309
KM SD (logged)	0.475	95% Critical H Value (KM-Log)	1.944
KM Standard Error of Mean (logged)	0.1		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00377	Mean in Log Scale	-6.251

SD in Original Scale	0.00799	SD in Log Scale	0.952
95% t UCL (Assumes normality)	0.00644	95% H-Stat UCL	0.00483

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.00314	95% KM (Percentile Bootstrap) UCL	0.00315

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Dibenzofuran

General Statistics

Total Number of Observations	26	Number of Distinct Observations	24
Number of Detects	25	Number of Non-Detects	1
Number of Distinct Detects	23	Number of Distinct Non-Detects	1
Minimum Detect	0.022	Minimum Non-Detect	0.11
Maximum Detect	27	Maximum Non-Detect	0.11
Variance Detects	28.65	Percent Non-Detects	3.846%
Mean Detects	1.338	SD Detects	5.353
Median Detects	0.2	CV Detects	4
Skewness Detects	4.98	Kurtosis Detects	24.86
Mean of Logged Detects	-1.564	SD of Logged Detects	1.432

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.241	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.47	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.177	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.289	Standard Error of Mean	1.031
SD	5.149	95% KM (BCA) UCL	3.369
95% KM (t) UCL	3.049	95% KM (Percentile Bootstrap) UCL	3.342
95% KM (z) UCL	2.984	95% KM Bootstrap t UCL	33.01
90% KM Chebyshev UCL	4.381	95% KM Chebyshev UCL	5.781
97.5% KM Chebyshev UCL	7.725	99% KM Chebyshev UCL	11.54

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.066	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.838	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.337	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.188	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.361	k star (bias corrected MLE)	0.344
Theta hat (MLE)	3.711	Theta star (bias corrected MLE)	3.89
nu hat (MLE)	18.03	nu star (bias corrected)	17.2
MLE Mean (bias corrected)	1.338	MLE Sd (bias corrected)	2.282

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.0626	nu hat (KM)	3.258
Approximate Chi Square Value (3.26, α)	0.453	Adjusted Chi Square Value (3.26, β)	0.394
95% Gamma Approximate KM-UCL (use when n>=50)	9.274	95% Gamma Adjusted KM-UCL (use when n<50)	10.64

Gamma (KM) may not be used when k hat (KM) is < 0.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.287
Maximum	27	Median	0.185
SD	5.251	CV	4.08
k hat (MLE)	0.348	k star (bias corrected MLE)	0.334
Theta hat (MLE)	3.698	Theta star (bias corrected MLE)	3.859
nu hat (MLE)	18.1	nu star (bias corrected)	17.34
MLE Mean (bias corrected)	1.287	MLE Sd (bias corrected)	2.229
		Adjusted Level of Significance (β)	0.0398
Approximate Chi Square Value (17.34, α)	8.918	Adjusted Chi Square Value (17.34, β)	8.52
95% Gamma Approximate UCL (use when n>=50)	2.503	95% Gamma Adjusted UCL (use when n<50)	2.62

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.892	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.138	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.177	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.288	Mean in Log Scale	-1.623
SD in Original Scale	5.251	SD in Log Scale	1.435
95% t UCL (assumes normality of ROS data)	3.047	95% Percentile Bootstrap UCL	3.352
95% BCA Bootstrap UCL	4.45	95% Bootstrap t UCL	33.36
95% H-UCL (Log ROS)	1.35		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-1.622	95% H-UCL (KM -Log)	1.269
KM SD (logged)	1.409	95% Critical H Value (KM-Log)	3.079
KM Standard Error of Mean (logged)	0.283		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.289	Mean in Log Scale	-1.616
SD in Original Scale	5.251	SD in Log Scale	1.427
95% t UCL (Assumes normality)	3.048	95% H-Stat UCL	1.335

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	7.725

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Di-n-octyl phthalate

General Statistics

Total Number of Observations	26	Number of Distinct Observations	16
Number of Detects	1	Number of Non-Detects	25
Number of Distinct Detects	1	Number of Distinct Non-Detects	15

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Di-n-octyl phthalate was not processed!

Selenium

General Statistics

Total Number of Observations	26	Number of Distinct Observations	19
Number of Detects	12	Number of Non-Detects	14
Number of Distinct Detects	9	Number of Distinct Non-Detects	11
Minimum Detect	1.1	Minimum Non-Detect	0.81
Maximum Detect	3.4	Maximum Non-Detect	9.8
Variance Detects	0.412	Percent Non-Detects	53.85%
Mean Detects	1.867	SD Detects	0.641
Median Detects	1.75	CV Detects	0.344
Skewness Detects	1.247	Kurtosis Detects	2.005
Mean of Logged Detects	0.575	SD of Logged Detects	0.323

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.888	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.229	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.256	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.338	Standard Error of Mean	0.146
SD	0.684	95% KM (BCA) UCL	1.617
95% KM (t) UCL	1.587	95% KM (Percentile Bootstrap) UCL	1.583
95% KM (z) UCL	1.578	95% KM Bootstrap t UCL	1.653
90% KM Chebyshev UCL	1.776	95% KM Chebyshev UCL	1.974
97.5% KM Chebyshev UCL	2.249	99% KM Chebyshev UCL	2.789

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.388	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.73	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.186	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.245	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	10.33	k star (bias corrected MLE)	7.803
Theta hat (MLE)	0.181	Theta star (bias corrected MLE)	0.239

nu hat (MLE)	247.9	nu star (bias corrected)	187.3
MLE Mean (bias corrected)	1.867	MLE Sd (bias corrected)	0.668

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	3.829	nu hat (KM)	199.1
Approximate Chi Square Value (199.12, α)	167.5	Adjusted Chi Square Value (199.12, β)	165.6
95% Gamma Approximate KM-UCL (use when n>=50)	1.591	95% Gamma Adjusted KM-UCL (use when n<50)	1.61

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.135	Mean	1.112
Maximum	3.4	Median	1.012
SD	0.854	CV	0.768
k hat (MLE)	1.563	k star (bias corrected MLE)	1.409
Theta hat (MLE)	0.711	Theta star (bias corrected MLE)	0.789
nu hat (MLE)	81.3	nu star (bias corrected)	73.25
MLE Mean (bias corrected)	1.112	MLE Sd (bias corrected)	0.937
		Adjusted Level of Significance (β)	0.0398
Approximate Chi Square Value (73.25, α)	54.54	Adjusted Chi Square Value (73.25, β)	53.48
95% Gamma Approximate UCL (use when n>=50)	1.493	95% Gamma Adjusted UCL (use when n<50)	1.523

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.168	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.256	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.292	Mean in Log Scale	0.136
SD in Original Scale	0.699	SD in Log Scale	0.486
95% t UCL (assumes normality of ROS data)	1.526	95% Percentile Bootstrap UCL	1.512
95% BCA Bootstrap UCL	1.551	95% Bootstrap t UCL	1.589
95% H-UCL (Log ROS)	1.558		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	0.182	95% H-UCL (KM -Log)	1.578
KM SD (logged)	0.45	95% Critical H Value (KM-Log)	1.924
KM Standard Error of Mean (logged)	0.0958		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.447	Mean in Log Scale	0.0304
SD in Original Scale	1.282	SD in Log Scale	0.832
95% t UCL (Assumes normality)	1.877	95% H-Stat UCL	2.137

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.587	95% KM (Percentile Bootstrap) UCL	1.583

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Table B1.1
SMA 5 - Daily Intake Calculations: Industrial/Commercial Worker
Ingestion of Chemicals in Surface Soil, 0 - 1 ft depth
ERP Coke Facility, Birmingham, Alabama

Equation	$DI_{ingestion}$	= [	CS	x	IR	x	FI	x	CF	x	EF	x	ED	] / [	BW	x	AT	]
Units	**mg/kg-day**		**mg/kg**		**mg soil/day**		**unitless**		**kg/mg**		**days/year**		**years**		**kg**		**days**	
CARCINOGENIC EFFECTS																		
Benz(a)anthracene	1.67E-07	= [	1.09E+00	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	25,550	]
Benzo(a)pyrene	1.61E-07	= [	1.05E+00	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	25,550	]
Benzo(b)fluoranthene	2.67E-07	= [	1.75E+00	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	25,550	]
Benzo(k)fluoranthene	8.61E-08	= [	5.63E-01	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	25,550	]
Carbazole	7.95E-09	= [	5.20E-02	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	25,550	]
Chrysene	2.29E-07	= [	1.50E+00	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	25,550	]
Dibenz(a,h)anthracene	4.59E-08	= [	3.00E-01	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	25,550	]
Indeno(1,2,3-cd)pyrene	1.11E-07	= [	7.24E-01	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	25,550	]
Arsenic	1.91E-06	= [	1.25E+01	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	25,550	]
Chromium	4.11E-06	= [	2.69E+01	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	25,550	]
NONCARCINOGENIC EFFECTS																		
Benz(a)anthracene	4.68E-07	= [	1.09E+00	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	9,125	]
Benzo(a)pyrene	4.50E-07	= [	1.05E+00	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	9,125	]
Benzo(b)fluoranthene	7.49E-07	= [	1.75E+00	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	9,125	]
Benzo(k)fluoranthene	2.41E-07	= [	5.63E-01	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	9,125	]
Carbazole	2.23E-08	= [	5.20E-02	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	9,125	]
Chrysene	6.42E-07	= [	1.50E+00	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	9,125	]
Dibenz(a,h)anthracene	1.28E-07	= [	3.00E-01	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	9,125	]
Indeno(1,2,3-cd)pyrene	3.10E-07	= [	7.24E-01	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	9,125	]
Arsenic	5.36E-06	= [	1.25E+01	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	9,125	]
Chromium	1.15E-05	= [	2.69E+01	x	50	x	1	x	1.00E-06	x	250	x	25	] / [	80	x	9,125	]

$DI_{ingestion}$ = daily chemical intake via soil ingestion
CS = chemical concentration in soil
IR = soil ingestion rate
FI = fraction of intake
CF = conversion factor
EF = exposure frequency
ED = exposure duration
BW = body weight
AT = averaging time

Table B1.2
SMA 5 - Daily Intake Calculations: Construction Worker
Ingestion of Chemicals in Soil
ERP Coke Facility, Birmingham, Alabama

Equation	$DI_{ingestion}$	= [	CS	x	IR	x	FI	x	CF	x	EF	x	ED	] / [	BW	x	AT	]
Units	mg/kg-day		mg/kg		mg soil/day		unitless		kg/mg		days/year		years		kg		days	
CARCINOGENIC EFFECTS																		
Benz(a)anthracene	2.03E-07	= [	5.03E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	25,550	]
Benzo(a)pyrene	4.77E-07	= [	1.18E+01	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	25,550	]
Benzo(b)fluoranthene	4.22E-07	= [	1.05E+01	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	25,550	]
Benzo(k)fluoranthene	1.45E-07	= [	3.59E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	25,550	]
Carbazole	8.10E-08	= [	2.01E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	25,550	]
Chrysene	2.59E-07	= [	6.41E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	25,550	]
Dibenz(a,h)anthracene	1.17E-07	= [	2.91E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	25,550	]
Indeno(1,2,3-cd)pyrene	3.94E-07	= [	9.76E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	25,550	]
Naphthalene	2.41E-06	= [	5.96E+01	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	25,550	]
Arsenic	5.57E-07	= [	1.38E+01	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	25,550	]
Chromium	1.66E-06	= [	4.11E+01	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	25,550	]
Mercury	1.02E-07	= [	2.52E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	25,550	]
NONCARCINOGENIC EFFECTS																		
Benz(a)anthracene	1.42E-05	= [	5.03E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	365	]
Benzo(a)pyrene	3.34E-05	= [	1.18E+01	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	365	]
Benzo(b)fluoranthene	2.96E-05	= [	1.05E+01	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	365	]
Benzo(k)fluoranthene	1.02E-05	= [	3.59E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	365	]
Carbazole	5.67E-06	= [	2.01E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	365	]
Chrysene	1.81E-05	= [	6.41E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	365	]
Dibenz(a,h)anthracene	8.21E-06	= [	2.91E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	365	]
Indeno(1,2,3-cd)pyrene	2.76E-05	= [	9.76E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	365	]
Naphthalene	1.68E-04	= [	5.96E+01	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	365	]
Arsenic	3.90E-05	= [	1.38E+01	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	365	]
Chromium	1.16E-04	= [	4.11E+01	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	365	]
Mercury	7.12E-06	= [	2.52E+00	x	330	x	1	x	1.00E-06	x	250	x	1	] / [	80	x	365	]

$DI_{ingestion}$ = daily chemical intake via soil ingestion
CS = chemical concentration in soil
IR = soil ingestion rate
FI = fraction of intake
CF = conversion factor
EF = exposure frequency
ED = exposure duration
BW = body weight
AT = averaging time

Table B1.3
SMA 5 - Kd Calculations, Soil 0 - 1 ft depth
ERP Coke Facility, Birmingham, Alabama

Chemical	Koc	x	foc	=	Kd
Benz(a)anthracene	1.77E+05	x	0.006	=	1.06E+03
Benzo(a)pyrene	5.87E+05	x	0.006	=	3.52E+03
Benzo(b)fluoranthene	5.99E+05	x	0.006	=	3.60E+03
Benzo(k)fluoranthene	5.87E+05	x	0.006	=	3.52E+03
Carbazole	ND	x	0.006	=	na
Chrysene	1.81E+05	x	0.006	=	1.08E+03
Dibenz(a,h)anthracene	1.91E+06	x	0.006	=	1.15E+04
Indeno(1,2,3-cd)pyrene	1.95E+06	x	0.006	=	1.17E+04
Arsenic	ND	x	0.006	=	na
Chromium	ND	x	0.006	=	na

K_{OC} = soil organic carbon partition coefficient (cm^3 / g), chemical specific

Source for K_{OC} = USEPA Region 9 RSL Table, June 2015.

f_{OC} = fraction organic carbon in soil (g/g), 0.006

K_d = soil-water partition coefficient (cm^3/g) = K_{OC} x f_{OC}, chemical specific

nd = no data

na = not applicable

Table B1.4
SMA 5 - Kd Calculations, Soil 0 - 9 ft
ERP Coke Facility, Birmingham, Alabama

Chemical	Koc	x	foc	=	Kd
Benz(a)anthracene	1.77E+05	x	0.006	=	1.06E+03
Benzo(a)pyrene	5.87E+05	x	0.006	=	3.52E+03
Benzo(b)fluoranthene	5.99E+05	x	0.006	=	3.60E+03
Benzo(k)fluoranthene	5.87E+05	x	0.006	=	3.52E+03
Carbazole	0.00E+00	x	0.006	=	0.00E+00
Chrysene	1.81E+05	x	0.006	=	1.08E+03
Dibenz(a,h)anthracene	1.91E+06	x	0.006	=	1.15E+04
Indeno(1,2,3-cd)pyrene	1.95E+06	x	0.006	=	1.17E+04
Naphthalene	1.54E+03	x	0.006	=	9.26E+00
Arsenic	ND	x	0.006	=	na
Chromium	ND	x	0.006	=	na
Mercury	ND	x	0.006	=	na

K_{OC} = soil organic carbon partition coefficient (cm^3 / g), chemical specific

Source for K_{OC} = USEPA Region 9 RSL Table, June 2015

f_{OC} = fraction organic carbon in soil (g/g), 0.006

K_d = soil-water partition coefficient (cm^3/g) = K_{OC} x f_{OC}, chemical specific

nd = no data

na = not applicable

Table B1.5
SMA 5 - Derivation of Dispersion Factors, Surface Soil
ERP Coke Facility, Birmingham, Alabama

Equation	Q/C	=	A	x	exp	[	(	ln	A_{site}	-	B	$)^2$	/	C	]
Units	g/m^2-s per kg/m^3		unitless						ac		unitless			unitless	
SMA 5	59.65	=	14.8349	x	exp	[	(	ln	3	-	17.9529	$)^2$	/	204.1516	]

Source: USEPA. 2002. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.* Office of Solid Waste and Emergency Response, OSWER 9355.4-24. Washington, DC.

Q/C = inverse of mean concentration at center of source (g/m^2-s per kg/m^3).
Constants A, B, and C based on Zone 6, Atlanta, GA
A_{site} = approx. 3 acres

Table B1.6
Derivation of Dispersion Factors
ERP Coke Facility, Birmingham, Alabama

Equation	Q/C	=	A	x	exp	[	(	ln	A_{site}	-	B	$)^2$	/	C	]
Units	g/m^2-s per kg/m^3		unitless						ac		unitless			unitless	
SMA 5	59.65	=	14.8349	x	exp	[	(	ln	3	-	17.9529	$)^2$	/	204.1516	]

Source: USEPA. 2002. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.* Office of Solid Waste and Emergency Response, OSWER 9355.4-24. Washington, DC.

Q/C = inverse of mean concentration at center of source (g/m^2-s per kg/m^3).
Constants A, B, and C based on Zone 6, Atlanta, GA
A_{site} = approx. 3 acres

Table B1.7

Apparent Diffusivity - DA

ERP Coke Facility, Birmingham, Alabama

Equation:	DA	= [(	$\theta_a^{10/3}$	x	D_i	x	H'	) + (	$\theta_w^{10/3}$	x	D_w	) /	n^2	] / [(	ρ_b	x	K_d	) +	θ_w	+ (	θ_a	x	H'	)]
Units:	cm^2/sec		L_{air}/L_{soil}		cm^2/sec		unitless		m^3/kg		cm^2/sec		unitless		g/cm^3								unitless	
Benz(a)anthracene	2.71E-10	= [(	1.50E-02	x	0.050865	x	0.0004906	) + (	0.00179	x	5.9431E-06	) /	0.1884	] / [(	1.5	x	1.06E+03	) +	0.15	+ (	0.284	x	0.00049060	)]
Benzo(a)pyrene	1.25E-11	= [(	1.50E-02	x	0.047583	x	0.0000187	) + (	0.00179	x	5.5597E-06	) /	0.1884	] / [(	1.5	x	3.52E+03	) +	0.15	+ (	0.284	x	0.00001870	)]
Benzo(b)fluoranthene	1.34E-11	= [(	1.50E-02	x	0.047583	x	0.0000269	) + (	0.00179	x	5.5597E-06	) /	0.1884	] / [(	1.5	x	3.60E+03	) +	0.15	+ (	0.284	x	0.00002690	)]
Benzo(k)fluoranthene	1.32E-11	= [(	1.50E-02	x	0.047583	x	0.0000239	) + (	0.00179	x	5.5597E-06	) /	0.1884	] / [(	1.5	x	3.52E+03	) +	0.15	+ (	0.284	x	0.00002390	)]
Carbazole	na	= [(	1.50E-02	x	ND	x	ND	) + (	0.00179	x	ND	) /	0.1884	] / [(	1.5	x	na	) +	0.15	+ (	0.284	x	ND	)]
Chrysene	9.10E-11	= [(	1.50E-02	x	0.026114	x	0.0002138	) + (	0.00179	x	6.7495E-06	) /	0.1884	] / [(	1.5	x	1.08E+03	) +	0.15	+ (	0.284	x	0.00021380	)]
Dibenz(a,h)anthracene	3.10E-12	= [(	1.50E-02	x	0.044567	x	0.0000058	) + (	0.00179	x	5.2073E-06	) /	0.1884	] / [(	1.5	x	1.15E+04	) +	0.15	+ (	0.284	x	0.00000576	)]
Indeno(1,2,3-cd)pyrene	3.38E-12	= [(	1.50E-02	x	0.044784	x	0.0000142	) + (	0.00179	x	5.2327E-06	) /	0.1884	] / [(	1.5	x	1.17E+04	) +	0.15	+ (	0.284	x	0.00001420	)]
Arsenic	na	= [(	1.50E-02	x	ND	x	ND	) + (	0.00179	x	ND	) /	0.1884	] / [(	1.5	x	na	) +	0.15	+ (	0.284	x	ND	)]
Chromium	na	= [(	1.50E-02	x	ND	x	ND	) + (	0.00179	x	ND	) /	0.1884	] / [(	1.5	x	na	) +	0.15	+ (	0.284	x	ND	)]

Equation Source: USEPA. 2002. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.* Office of Solid Waste and Emergency Response, OSWER 9355.4-24.

Parameters Source: USEPA Region 9 RSL Parameter Tables, June 2015.

nd = no data   na = not applicable

DA = apparent diffusivity

D_i = diffusivity in air (cm^2/sec), chemical specific

θ_a = air filled porosity (L_{air}/L_{soil}) = n - θ_w = 0.284

H' = Henrys law constant, unitless, chemical specific

θ_w = water-filled porosity (L_{water}/L_{soil}) = 0.15

D_w = diffusivity in water (cm^2/sec), chemical specific

n = total soil porosity (L_{pore}/L_{soil}) = 1 - (ρ_b/ρ_s) = 0.434

K_d = soil-water partition coefficient, cm^3/g) = K_{OC} x f_{OC}, chemical specific

ρ_b = dry soil bulk density (g/cm^3) = 1.5 g/cm^3

K_{OC} = soil organic carbon partition coefficient (cm^3 / g), chemical specific

ρ_s = soil particle density (g/cm^3) = 2.65 g/cm^3

f_{OC} = fraction organic carbon in soil (g/g), 0.006

Table B1.8
Apparent Diffusivity - DA
ERP Coke Facility, Birmingham, Alabama

Equation:	DA	= [(	$\theta_a^{10/3}$	x	D_i	x	H'	) + (	$\theta_w^{10/3}$	x	D_w	) /	n^2	] / [(	ρ_b	x	K_d	) +	θ_w	+ (	θ_a	x	H'	)]
Units:	cm^2/sec		L_{air}/L_{soil}		cm^2/sec		unitless		m^3/kg		cm^2/sec		unitless		g/cm^3								unitless	
Benz(a)anthracene	2.71E-10	= [(	1.50E-02	x	0.050865	x	0.0004906	) + (	0.00179	x	5.9431E-06	) /	0.1884	] / [(	1.5	x	1.06E+03	) +	0.15	+ (	0.284	x	0.00049060	)]
Benzo(a)pyrene	1.25E-11	= [(	1.50E-02	x	0.047583	x	0.0000187	) + (	0.00179	x	5.5597E-06	) /	0.1884	] / [(	1.5	x	3.52E+03	) +	0.15	+ (	0.284	x	0.00001870	)]
Benzo(b)fluoranthene	1.34E-11	= [(	1.50E-02	x	0.047583	x	0.0000269	) + (	0.00179	x	5.5597E-06	) /	0.1884	] / [(	1.5	x	3.60E+03	) +	0.15	+ (	0.284	x	0.00002690	)]
Benzo(k)fluoranthene	1.32E-11	= [(	1.50E-02	x	0.047583	x	0.0000239	) + (	0.00179	x	5.5597E-06	) /	0.1884	] / [(	1.5	x	3.52E+03	) +	0.15	+ (	0.284	x	0.00002390	)]
Carbazole	na	= [(	1.50E-02	x	ND	x	ND	) + (	0.00179	x	ND	) /	0.1884	] / [(	1.5	x	0.00E+00	) +	0.15	+ (	0.284	x	ND	)]
Chrysene	9.10E-11	= [(	1.50E-02	x	0.026114	x	0.0002138	) + (	0.00179	x	6.7495E-06	) /	0.1884	] / [(	1.5	x	1.08E+03	) +	0.15	+ (	0.284	x	0.00021380	)]
Dibenz(a,h)anthracene	3.10E-12	= [(	1.50E-02	x	0.044567	x	5.765E-06	) + (	0.00179	x	5.2073E-06	) /	0.1884	] / [(	1.5	x	1.15E+04	) +	0.15	+ (	0.284	x	0.00000576	)]
Indeno(1,2,3-cd)pyrene	3.38E-12	= [(	1.50E-02	x	0.044784	x	0.0000142	) + (	0.00179	x	5.2327E-06	) /	0.1884	] / [(	1.5	x	1.17E+04	) +	0.15	+ (	0.284	x	0.00001420	)]
Naphthalene	1.17E-06	= [(	1.50E-02	x	0.060499	x	0.0179886	) + (	0.00179	x	8.377E-06	) /	0.1884	] / [(	1.5	x	9.26E+00	) +	0.15	+ (	0.284	x	0.01798860	)]
Arsenic	na	= [(	1.50E-02	x	ND	x	ND	) + (	0.00179	x	ND	) /	0.1884	] / [(	1.5	x	na	) +	0.15	+ (	0.284	x	ND	)]
Chromium	na	= [(	1.50E-02	x	ND	x	ND	) + (	0.00179	x	ND	) /	0.1884	] / [(	1.5	x	na	) +	0.15	+ (	0.284	x	ND	)]
Mercury	na	= [(	1.50E-02	x	0.0307	x	0.467	) + (	0.00179	x	0.0000063	) /	0.1884	] / [(	1.5	x	na	) +	0.15	+ (	0.284	x	0.46700000	)]

Equation Source: USEPA. 2002. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.* Office of Solid Waste and Emergency Response, OSWER 9355.4-24.

Parameters Source: USEPA Region 9 RSL Parameter Tables, June 2015.

nd = no data na = not applicable

DA = apparent diffusivity

D_i = diffusivity in air (cm^2/sec), chemical specific

θ_a = air filled porosity (L_{air}/L_{soil}) = n - θ_w = 0.284

H' = Henrys law constant, unitless, chemical specific

θ_w = water-filled porosity (L_{water}/L_{soil}) = 0.15

D_w = diffusivity in water (cm^2/sec), chemical specific

n = total soil porosity (L_{pore}/L_{soil}) = 1 - (ρ_b/ρ_s) = 0.434

K_d = soil-water partition coefficient, cm^3/g) = K_{OC} x f_{OC}, chemical specific

ρ_b = dry soil bulk density (g/cm^3) = 1.5 g/cm^3

K_{OC} = soil organic carbon partition coefficient (cm^3 / g), chemical specific

ρ_s = soil particle density (g/cm^3) = 2.65 g/cm^3

f_{OC} = fraction organic carbon in soil (g/g), 0.006

Table B1.9

Volatilization Factor Calculations[1] - VF

ERP Coke Facility, Birmingham, Alabama

Equation:	VF	= [	Q/C	x (	3.14	x	D_A	x	T	$)^{1/2}$	x	CF	] / (	2	x	ρ_b	x	D_A	)
Units:	m^3/kg		g/m^2-s per kg/m^3				cm^2/sec		sec									cm^2/sec	
Benz(a)anthracene	6.60E+06	= [	59.65	x (	3.14	x	2.71E-10	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	2.71E-10	)
Benzo(a)pyrene	3.07E+07	= [	59.65	x (	3.14	x	1.25E-11	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	1.25E-11	)
Benzo(b)fluoranthene	2.97E+07	= [	59.65	x (	3.14	x	1.34E-11	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	1.34E-11	)
Benzo(k)fluoranthene	2.99E+07	= [	59.65	x (	3.14	x	1.32E-11	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	1.32E-11	)
Carbazole	na	= [	59.65	x (	3.14	x	na	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	na	)
Chrysene	1.14E+07	= [	59.65	x (	3.14	x	9.10E-11	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	9.10E-11	)
Dibenz(a,h)anthracene	6.17E+07	= [	59.65	x (	3.14	x	3.10E-12	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	3.10E-12	)
Indeno(1,2,3-cd)pyrene	5.91E+07	= [	59.65	x (	3.14	x	3.38E-12	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	3.38E-12	)
Arsenic	na	= [	59.65	x (	3.14	x	na	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	na	)
Chromium	na	= [	59.65	x (	3.14	x	na	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	na	)

Source: USEPA. 2002. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.* Office of Solid Waste and Emergency Response, OSWER 9355.4-24. Washington, DC.

Q/C = inverse of mean concentration at center of source (g/m2-s per kg/m3).

na = not applicable

D_A = apparent diffusivity (cm^2/sec)

T = exposure interval (sec)

CF = conversion factor, 10^{-4} m^2/cm^2

VF = volatilazation factor

ρ_b = dry soil bulk density (g/cm^3) = 1.5 g/cm^3

Table B1.10

Volatilization Factor Calculations[1] - VF

ERP Coke Facility, Birmingham, Alabama

Equation:	**VF**	**= [**	**Q/C**	**x (**	**3.14**	**x**	**D_A**	**x**	**T**	**$)^{1/2}$**	**x**	**CF**	**] / (**	**2**	**x**	**ρ_b**	**x**	**D_A**	**)**
Units:	**m^3/kg**		**g/m^2-s per kg/m^3**				**cm^2/sec**		**sec**									**cm^2/sec**	
Benz(a)anthracene	6.60E+06	= [	59.65	x (	3.14	x	2.71E-10	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	2.71E-10	)
Benzo(a)pyrene	3.07E+07	= [	59.65	x (	3.14	x	1.25E-11	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	1.25E-11	)
Benzo(b)fluoranthene	2.97E+07	= [	59.65	x (	3.14	x	1.34E-11	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	1.34E-11	)
Benzo(k)fluoranthene	2.99E+07	= [	59.65	x (	3.14	x	1.32E-11	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	1.32E-11	)
Carbazole	na	= [	59.65	x (	3.14	x	na	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	na	)
Chrysene	1.14E+07	= [	59.65	x (	3.14	x	9.10E-11	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	9.10E-11	)
Dibenz(a,h)anthracene	6.17E+07	= [	59.65	x (	3.14	x	3.10E-12	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	3.10E-12	)
Indeno(1,2,3-cd)pyrene	5.91E+07	= [	59.65	x (	3.14	x	3.38E-12	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	3.38E-12	)
Naphthalene	1.01E+05	= [	59.65	x (	3.14	x	1.17E-06	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	1.17E-06	)
Arsenic	na	= [	59.65	x (	3.14	x	na	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	na	)
Chromium	na	= [	59.65	x (	3.14	x	na	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	na	)
Mercury	na	= [	59.65	x (	3.14	x	na	x	9.50E+08	$)^{1/2}$	x	1.00E-04	] / (	2	x	1.5	x	na	)

Source: USEPA. 2002. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.* Office of Solid Waste and Emergency Response, OSWER 9355.4-24. Washington, DC.

Q/C = inverse of mean concentration at center of source (g/m2-s per kg/m3).

na = not applicable

D_A = apparent diffusivity (cm^2/sec)

T = exposure interval (sec)

CF = conversion factor, 10^{-4} m^2/cm^2

VF = volatilazation factor

ρ_b = dry soil bulk density (g/cm^3) = 1.5 g/cm^3

Table B1.11

SMA 5 - Chemical Concentrations in Air Calculations, Surface Soil, 0 - 1 ft

ERP Coke Facility, Birmingham, Alabama

Equation	CA	=	CS	x	CF	x	[	(	1	/	PEF	)	+	(	1	/	VF	)	]
Units	µg/m³		mg/kg		µg/mg						m³/kg						m³/kg		
Benz(a)anthracene	1.66E-04	=	1.09E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	6.60E+06	)	]
Benzo(a)pyrene	3.44E-05	=	1.05E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	3.07E+07	)	]
Benzo(b)fluoranthene	5.92E-05	=	1.75E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	2.97E+07	)	]
Benzo(k)fluoranthene	1.90E-05	=	5.63E-01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	2.99E+07	)	]
Carbazole	9.12E-09	=	5.20E-02	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	na	)	]
Chrysene	1.32E-04	=	1.50E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	1.14E+07	)	]
Dibenz(a,h)anthracene	4.92E-06	=	3.00E-01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	6.17E+07	)	]
Indeno(1,2,3-cd)pyrene	1.24E-05	=	7.24E-01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	5.91E+07	)	]
Arsenic	2.19E-06	=	1.25E+01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	na	)	]
Chromium	4.71E-06	=	2.69E+01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	na	)	]

CA = chemical concentration in air

CS = chemical concentration in soil

CF = conversion factor (1000 µg/mg)

PEF = particulate emission factor

Table B1.12
SMA 5 - Chemical Concentrations in Air Calculations, Soil 0 - 9 ft
ERP Coke Facility, Birmingham, Alabama

Equation	CA	=	CS	x	CF	x	[	(	1	/	PEF	)	+	(	1	/	VF	)	]
Units	µg/m^3		mg/kg		µg/mg						m^3/kg						m^3/kg		
Industrial/Commercial Worker																			
Benz(a)anthracene	7.63E-04	=	5.03E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	6.60E+06	)	]
Benzo(a)pyrene	3.87E-04	=	1.18E+01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	3.07E+07	)	]
Benzo(b)fluoranthene	3.54E-04	=	1.05E+01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	2.97E+07	)	]
Benzo(k)fluoranthene	1.21E-04	=	3.59E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	2.99E+07	)	]
Carbazole	3.52E-07	=	2.01E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	na	)	]
Chrysene	5.64E-04	=	6.41E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	1.14E+07	)	]
Dibenz(a,h)anthracene	4.76E-05	=	2.91E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	6.17E+07	)	]
Indeno(1,2,3-cd)pyrene	1.67E-04	=	9.76E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	5.91E+07	)	]
Naphthalene	5.93E-01	=	5.96E+01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	1.01E+05	)	]
Arsenic	2.42E-06	=	1.38E+01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	na	)	]
Chromium	7.21E-06	=	4.11E+01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	na	)	]
Mercury	4.42E-07	=	2.52E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	na	)	]
Construction Worker																			
Benz(a)anthracene	7.63E-04	=	5.03E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	6.60E+06	)	]
Benzo(a)pyrene	3.87E-04	=	1.18E+01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	3.07E+07	)	]
Benzo(b)fluoranthene	3.54E-04	=	1.05E+01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	2.97E+07	)	]
Benzo(k)fluoranthene	1.21E-04	=	3.59E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	2.99E+07	)	]
Carbazole	3.52E-07	=	2.01E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	na	)	]
Chrysene	5.64E-04	=	6.41E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	1.14E+07	)	]
Dibenz(a,h)anthracene	4.76E-05	=	2.91E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	6.17E+07	)	]
Indeno(1,2,3-cd)pyrene	1.67E-04	=	9.76E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	5.91E+07	)	]
Naphthalene	5.93E-01	=	5.96E+01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	1.01E+05	)	]
Arsenic	2.42E-06	=	1.38E+01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	na	)	]
Chromium	7.21E-06	=	4.11E+01	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	na	)	]
Mercury	4.42E-07	=	2.52E+00	x	1000	x	[	(	1	/	5.70E+09	)	+	(	1	/	na	)	]

CA = chemical concentration in air
CS = chemical concentration in soil
CF = conversion factor (1000 µg/mg)
PEF = particulate emission factor

Table B1.13
SMA 5 - Daily Intake Calculations: Industrial/Commercial Worker
Inhalation of Chemicals in Surface Soil, 0 - 1 ft depth
ERP Coke Facility, Birmingham, Alabama

Equation	**EC**	**= [**	**CA**	**x**	**ET**	**x**	**EF**	**x**	**ED**	**x**	**CF**	**] / [**	**AT**	**]**
Units	**μg/m³**		**μg/m³**		**hours/day**		**days/year**		**years**		**days/hour**		**days**	
CARCINOGENIC EFFECTS														
Benz(a)anthracene	1.36E-05	= [	1.66E-04	x	8	x	250	x	25	x	0.042	] / [	25,550	]
Benzo(a)pyrene	2.83E-06	= [	3.44E-05	x	8	x	250	x	25	x	0.042	] / [	25,550	]
Benzo(b)fluoranthene	4.86E-06	= [	5.92E-05	x	8	x	250	x	25	x	0.042	] / [	25,550	]
Benzo(k)fluoranthene	1.56E-06	= [	1.90E-05	x	8	x	250	x	25	x	0.042	] / [	25,550	]
Carbazole	7.50E-10	= [	9.12E-09	x	8	x	250	x	25	x	0.042	] / [	25,550	]
Chrysene	1.09E-05	= [	1.32E-04	x	8	x	250	x	25	x	0.042	] / [	25,550	]
Dibenz(a,h)anthracene	4.04E-07	= [	4.92E-06	x	8	x	250	x	25	x	0.042	] / [	25,550	]
Indeno(1,2,3-cd)pyrene	1.02E-06	= [	1.24E-05	x	8	x	250	x	25	x	0.042	] / [	25,550	]
Arsenic	1.80E-07	= [	2.19E-06	x	8	x	250	x	25	x	0.042	] / [	25,550	]
Chromium	3.87E-07	= [	4.71E-06	x	8	x	250	x	25	x	0.042	] / [	25,550	]
NONCARCINOGENIC EFFECTS														
Benz(a)anthracene	3.81E-05	= [	1.66E-04	x	8	x	250	x	25		0.042	] / [	9,125	]
Benzo(a)pyrene	7.92E-06	= [	3.44E-05	x	8	x	250	x	25		0.042	] / [	9,125	]
Benzo(b)fluoranthene	1.36E-05	= [	5.92E-05	x	8	x	250	x	25		0.042	] / [	9,125	]
Benzo(k)fluoranthene	4.36E-06	= [	1.90E-05	x	8	x	250	x	25		0.042	] / [	9,125	]
Carbazole	2.10E-09	= [	9.12E-09	x	8	x	250	x	25		0.042	] / [	9,125	]
Chrysene	3.04E-05	= [	1.32E-04	x	8	x	250	x	25		0.042	] / [	9,125	]
Dibenz(a,h)anthracene	1.13E-06	= [	4.92E-06	x	8	x	250	x	25		0.042	] / [	9,125	]
Indeno(1,2,3-cd)pyrene	2.85E-06	= [	1.24E-05	x	8	x	250	x	25		0.042	] / [	9,125	]
Arsenic	5.05E-07	= [	2.19E-06	x	8	x	250	x	25		0.042	] / [	9,125	]
Chromium	1.08E-06	= [	4.71E-06	x	8	x	250	x	25		0.042	] / [	9,125	]

EC = exposure concentration
CA = chemical concentration in air
ET = exposure time
EF = exposure frequency
ED = exposure duration
CF = conversion factor (1 day/24 hours)
AT = averaging time

Table B1.14
SMA 5 - Daily Intake Calculations: Construction Worker
Inhalation of Chemicals in Soil 0 - 9 ft
ERP Coke Facility, Birmingham, Alabama

Equation	**EC**	**= [**	**CA**	**x**	**ET**	**x**	**EF**	**x**	**ED**	**x**	**CF**	**] / [**	**AT**	**]**
Units	**μg/m³**		**μg/m³**		**hours/day**		**days/year**		**years**		**day/hour**		**days**	
CARCINOGENIC EFFECTS														
Benz(a)anthracene	2.51E-06	= [	7.63E-04	x	8	x	250	x	1	x	0.042	] / [	25,550	]
Benzo(a)pyrene	1.27E-06	= [	3.87E-04	x	8	x	250	x	1	x	0.042	] / [	25,550	]
Benzo(b)fluoranthene	1.16E-06	= [	3.54E-04	x	8	x	250	x	1	x	0.042	] / [	25,550	]
Benzo(k)fluoranthene	3.98E-07	= [	1.21E-04	x	8	x	250	x	1	x	0.042	] / [	25,550	]
Carbazole	1.16E-09	= [	3.52E-07	x	8	x	250	x	1	x	0.042	] / [	25,550	]
Chrysene	1.85E-06	= [	5.64E-04	x	8	x	250	x	1	x	0.042	] / [	25,550	]
Dibenz(a,h)anthracene	1.57E-07	= [	4.76E-05	x	8	x	250	x	1	x	0.042	] / [	25,550	]
Indeno(1,2,3-cd)pyrene	5.49E-07	= [	1.67E-04	x	8	x	250	x	1	x	0.042	] / [	25,550	]
Naphthalene	1.95E-03	= [	5.93E-01	x	8	x	250	x	1	x	0.042	] / [	25,550	]
Arsenic	7.95E-09	= [	2.42E-06	x	8	x	250	x	1	x	0.042	] / [	25,550	]
Chromium	2.37E-08	= [	7.21E-06	x	8	x	250	x	1	x	0.042	] / [	25,550	]
Mercury	1.45E-09	= [	4.42E-07	x	8	x	250	x	1	x	0.042	] / [	25,550	]
NONCARCINOGENIC EFFECTS														
Benz(a)anthracene	1.76E-04	= [	7.63E-04	x	8	x	250	x	1	x	0.042	] / [	365	]
Benzo(a)pyrene	8.91E-05	= [	3.87E-04	x	8	x	250	x	1	x	0.042	] / [	365	]
Benzo(b)fluoranthene	8.14E-05	= [	3.54E-04	x	8	x	250	x	1	x	0.042	] / [	365	]
Benzo(k)fluoranthene	2.78E-05	= [	1.21E-04	x	8	x	250	x	1	x	0.042	] / [	365	]
Carbazole	8.10E-08	= [	3.52E-07	x	8	x	250	x	1	x	0.042	] / [	365	]
Chrysene	1.30E-04	= [	5.64E-04	x	8	x	250	x	1	x	0.042	] / [	365	]
Dibenz(a,h)anthracene	1.10E-05	= [	4.76E-05	x	8	x	250	x	1	x	0.042	] / [	365	]
Indeno(1,2,3-cd)pyrene	3.84E-05	= [	1.67E-04	x	8	x	250	x	1	x	0.042	] / [	365	]
Naphthalene	1.36E-01	= [	5.93E-01	x	8	x	250	x	1	x	0.042	] / [	365	]
Arsenic	5.57E-07	= [	2.42E-06	x	8	x	250	x	1	x	0.042	] / [	365	]
Chromium	1.66E-06	= [	7.21E-06	x	8	x	250	x	1	x	0.042	] / [	365	]
Mercury	1.02E-07	= [	4.42E-07	x	8	x	250	x	1	x	0.042	] / [	365	]

EC = exposure concentration
CA = chemical concentration in air
ET = exposure time
EF = exposure frequency
ED = exposure duration
CF = conversion factor (1 day/24 hours)
AT = averaging time

Table B1.15
SMA 5 - Daily Intake Calculations
Dermal Contact with Chemicals in Surface Soil, 0 - 1 ft - Absorbed dose per event (DA_{event})
ERP Coke Facility, Birmingham, Alabama

Equation	DA_{event}	= [	CS	x	CF	x	SAF	x	ABS_d
Units	mg/kg-event		mg/kg		kg/mg		mg/cm^2-event		unitless
Benz(a)anthracene	1.71E-08	= [	1.09E+00	x	1.00E-06	x	0.12	x	0.13
Benzo(a)pyrene	1.64E-08	= [	1.05E+00	x	1.00E-06	x	0.12	x	0.13
Benzo(b)fluoranthene	2.73E-08	= [	1.75E+00	x	1.00E-06	x	0.12	x	0.13
Benzo(k)fluoranthene	8.78E-09	= [	5.63E-01	x	1.00E-06	x	0.12	x	0.13
Carbazole	NA	= [	5.20E-02	x	1.00E-06	x	0.12	x	na
Chrysene	2.34E-08	= [	1.50E+00	x	1.00E-06	x	0.12	x	0.13
Dibenz(a,h)anthracene	4.68E-09	= [	3.00E-01	x	1.00E-06	x	0.12	x	0.13
Indeno(1,2,3-cd)pyrene	1.13E-08	= [	7.24E-01	x	1.00E-06	x	0.12	x	0.13
Arsenic	4.50E-08	= [	1.25E+01	x	1.00E-06	x	0.12	x	0.03
Chromium	NA	= [	2.69E+01	x	1.00E-06	x	0.12	x	ND

DA_{event} = absorbed dose per event (mg/cm^2-event)   na = not applicable
CS = chemical concentration in soil
CF = conversion factor
SAF =soil to skin adherence factor
ABS_d = dermal absorption fraction, per exhibit 3-4 in RAGS Part E, Dermal Risk Assessment (USEPA, 2004)

Table B1.16
SMA 5 - Daily Intake Calculations
Dermal Contact with Chemicals in Soil 0 - 9 ft - Absorbed dose per event (Da_{event})
ERP Coke Facility, Birmingham, Alabama

Equation	DA_{event}	= [	CS	x	CF	x	SAF	x	ABS_d
Units	mg/kg-event		mg/kg		kg/mg		mg/cm²-event		unitless
Benz(a)anthracene	7.85E-08	= [	5.03E+00	x	1.00E-06	x	0.12	x	0.13
Benzo(a)pyrene	1.84E-07	= [	1.18E+01	x	1.00E-06	x	0.12	x	0.13
Benzo(b)fluoranthene	1.63E-07	= [	1.05E+01	x	1.00E-06	x	0.12	x	0.13
Benzo(k)fluoranthene	5.61E-08	= [	3.59E+00	x	1.00E-06	x	0.12	x	0.13
Carbazole	NA	= [	2.01E+00	x	1.00E-06	x	0.12	x	NA
Chrysene	1.00E-07	= [	6.41E+00	x	1.00E-06	x	0.12	x	0.13
Dibenz(a,h)anthracene	4.53E-08	= [	2.91E+00	x	1.00E-06	x	0.12	x	0.13
Indeno(1,2,3-cd)pyrene	1.52E-07	= [	9.76E+00	x	1.00E-06	x	0.12	x	0.13
Naphthalene	9.30E-07	= [	5.96E+01	x	1.00E-06	x	0.12	x	0.13
Arsenic	4.96E-08	= [	1.38E+01	x	1.00E-06	x	0.12	x	0.03
Chromium	NA	= [	4.11E+01	x	1.00E-06	x	0.12	x	NA
Mercury	NA	= [	2.52E+00	x	1.00E-06	x	0.12	x	NA

DA_{event} = absorbed dose per event (mg/cm²-event)
na = not applicable
CS = chemical concentration in soil
CF = conversion factor
SAF =soil to skin adherence factor
ABS_d = dermal absorption fraction, per exhibit 3-4 in RAGS Part E, Dermal Risk Assessment (USEPA, 2004)

Table B1.17
SMA 5 - Daily Intake Calculations: Industrial/Commercial Worker
Dermal Contact with Chemicals in Surface Soil
ERP Coke Facility, Birmingham, Alabama

Equation	DAD	= [	DA_{event}	x	EF	x	ED	x	EV	x	SA	] / [	BW	x	AT	]
Units	mg/kg-day		mg/cm^2-event		days/year		years		events/day		cm^2		kg		days	
CARCINOGENIC EFFECTS																
Benz(a)anthracene	1.81E-07	= [	1.71E-08	x	250	x	25	x	1	x	3470	] / [	80	x	25,550	]
Benzo(a)pyrene	1.74E-07	= [	1.64E-08	x	250	x	25	x	1	x	3470	] / [	80	x	25,550	]
Benzo(b)fluoranthene	2.89E-07	= [	2.73E-08	x	250	x	25	x	1	x	3470	] / [	80	x	25,550	]
Benzo(k)fluoranthene	9.32E-08	= [	8.78E-09	x	250	x	25	x	1	x	3470	] / [	80	x	25,550	]
Carbazole	NA	= [	NA	x	250	x	25	x	1	x	3470	] / [	80	x	25,550	]
Chrysene	2.48E-07	= [	2.34E-08	x	250	x	25	x	1	x	3470	] / [	80	x	25,550	]
Dibenz(a,h)anthracene	4.97E-08	= [	4.68E-09	x	250	x	25	x	1	x	3470	] / [	80	x	25,550	]
Indeno(1,2,3-cd)pyrene	1.20E-07	= [	1.13E-08	x	250	x	25	x	1	x	3470	] / [	80	x	25,550	]
Arsenic	4.78E-07	= [	4.50E-08	x	250	x	25	x	1	x	3470	] / [	80	x	25,550	]
Chromium	NA	= [	NA	x	250	x	25	x	1	x	3470	] / [	80	x	25,550	]
NONCARCINOGENIC EFFECTS																
Benz(a)anthracene	5.07E-07	= [	1.71E-08	x	250	x	25	x	1	x	3470	] / [	80	x	9,125	]
Benzo(a)pyrene	4.87E-07	= [	1.64E-08	x	250	x	25	x	1	x	3470	] / [	80	x	9,125	]
Benzo(b)fluoranthene	8.11E-07	= [	2.73E-08	x	250	x	25	x	1	x	3470	] / [	80	x	9,125	]
Benzo(k)fluoranthene	2.61E-07	= [	8.78E-09	x	250	x	25	x	1	x	3470	] / [	80	x	9,125	]
Carbazole	NA	= [	NA	x	250	x	25	x	1	x	3470	] / [	80	x	9,125	]
Chrysene	6.95E-07	= [	2.34E-08	x	250	x	25	x	1	x	3470	] / [	80	x	9,125	]
Dibenz(a,h)anthracene	1.39E-07	= [	4.68E-09	x	250	x	25	x	1	x	3470	] / [	80	x	9,125	]
Indeno(1,2,3-cd)pyrene	3.36E-07	= [	1.13E-08	x	250	x	25	x	1	x	3470	] / [	80	x	9,125	]
Arsenic	1.34E-06	= [	4.50E-08	x	250	x	25	x	1	x	3470	] / [	80	x	9,125	]
Chromium	NA	= [	NA	x	250	x	25	x	1	x	3470	] / [	80	x	9,125	]

DAD = dermal absorbed dose (mg/kg-day)
DA_{event} = absorbed dose per event (mg/cm^2-event)
EF = exposure frequency (days/year)
ED = exposure duration (years)
EV = event frequency (events/day)
SA = skin surface area available for contact (cm^2)
BW = body weight
AT = averaging time

Table B1.18
SMA 5 - Daily Intake Calculations: Construction Worker
Dermal Contact with Chemicals in Soil 0 - 9 ft
ERP Coke Facility, Birmingham, Alabama

Equation	DAD	= [	DA_{event}	x	EF	x	ED	x	EV	x	SA	] / [	BW	x	AT	]
Units	mg/kg-day		mg/cm^2-event		days/year		years		events/day		cm^2		kg		days	
CARCINOGENIC EFFECTS																
Benz(a)anthracene	3.33E-08	= [	7.85E-08	x	250	x	1	x	1	x	3470	] / [	80	x	25,550	]
Benzo(a)pyrene	7.83E-08	= [	1.84E-07	x	250	x	1	x	1	x	3470	] / [	80	x	25,550	]
Benzo(b)fluoranthene	6.93E-08	= [	1.63E-07	x	250	x	1	x	1	x	3470	] / [	80	x	25,550	]
Benzo(k)fluoranthene	2.38E-08	= [	5.61E-08	x	250	x	1	x	1	x	3470	] / [	80	x	25,550	]
Carbazole	NA	= [	NA	x	250	x	1	x	1	x	3470	] / [	80	x	25,550	]
Chrysene	4.24E-08	= [	1.00E-07	x	250	x	1	x	1	x	3470	] / [	80	x	25,550	]
Dibenz(a,h)anthracene	1.92E-08	= [	4.53E-08	x	250	x	1	x	1	x	3470	] / [	80	x	25,550	]
Indeno(1,2,3-cd)pyrene	6.46E-08	= [	1.52E-07	x	250	x	1	x	1	x	3470	] / [	80	x	25,550	]
Naphthalene	3.95E-07	= [	9.30E-07	x	250	x	1	x	1	x	3470	] / [	80	x	25,550	]
Arsenic	2.11E-08	= [	4.96E-08	x	250	x	1	x	1	x	3470	] / [	80	x	25,550	]
Chromium	NA	= [	NA	x	250	x	1	x	1	x	3470	] / [	80	x	25,550	]
Mercury	NA	= [	NA	x	250	x	1	x	1	x	3470	] / [	80	x	25,550	]
NONCARCINOGENIC EFFECTS																
Benz(a)anthracene	2.33E-06	= [	7.85E-08	x	250	x	1	x	1	x	3470	] / [	80	x	365	]
Benzo(a)pyrene	5.48E-06	= [	1.84E-07	x	250	x	1	x	1	x	3470	] / [	80	x	365	]
Benzo(b)fluoranthene	4.85E-06	= [	1.63E-07	x	250	x	1	x	1	x	3470	] / [	80	x	365	]
Benzo(k)fluoranthene	1.67E-06	= [	5.61E-08	x	250	x	1	x	1	x	3470	] / [	80	x	365	]
Carbazole	NA	= [	NA	x	250	x	1	x	1	x	3470	] / [	80	x	365	]
Chrysene	2.97E-06	= [	1.00E-07	x	250	x	1	x	1	x	3470	] / [	80	x	365	]
Dibenz(a,h)anthracene	1.35E-06	= [	4.53E-08	x	250	x	1	x	1	x	3470	] / [	80	x	365	]
Indeno(1,2,3-cd)pyrene	4.53E-06	= [	1.52E-07	x	250	x	1	x	1	x	3470	] / [	80	x	365	]
Naphthalene	2.76E-05	= [	9.30E-07	x	250	x	1	x	1	x	3470	] / [	80	x	365	]
Arsenic	1.47E-06	= [	4.96E-08	x	250	x	1	x	1	x	3470	] / [	80	x	365	]
Chromium	NA	= [	NA	x	250	x	1	x	1	x	3470	] / [	80	x	365	]
Mercury	NA	= [	NA	x	250	x	1	x	1	x	3470	] / [	80	x	365	]

DAD = dermal absorbed dose (mg/kg-day)
DA_{event} = absorbed dose per event (mg/cm^2-event)
EF = exposure frequency (days/year)
ED = exposure duration (years)
EV = event frequency (events/day)
SA = skin surface area available for contact (cm^2)
BW = body weight
AT = averaging time

Table B2.1
Risk Characterization
Industrial/Commercial Workers Exposed to Surface Soil (0 - 1 ft) of SMA 5
ERP Coke Facility, Birmingham, Alabama

	Carcinogenic Effects					Noncarcinogenic Effects				
Equation	**DI**	**x**	**SF**	**=**	**CR**	**DI**	**/**	**RfD**	**=**	**HQ**
Units	**mg/kg-day**		**(mg/kg-day)-1**		**unitless**	**mg/kg-day**		**mg/kg-day**		**unitless**
Ingestion of Chemicals in Soil										
Benz(a)anthracene	1.67E-07	x	7.30E-01	=	1.22E-07	4.68E-07	/	NA	=	NA
Benzo(a)pyrene	1.61E-07	x	7.30E+00	=	**1.17E-06**	4.50E-07	/	NA	=	NA
Benzo(b)fluoranthene	2.67E-07	x	7.30E-01	=	1.95E-07	7.49E-07	/	NA	=	NA
Benzo(k)fluoranthene	8.61E-08	x	7.30E-02	=	6.28E-09	2.41E-07	/	NA	=	NA
Carbazole	7.95E-09	x	NA	=	NA	2.23E-08	/	NA	=	NA
Chrysene	2.29E-07	x	7.30E-03	=	1.67E-09	6.42E-07	/	NA	=	NA
Dibenz(a,h)anthracene	4.59E-08	x	7.30E+00	=	3.35E-07	1.28E-07	/	NA	=	NA
Indeno(1,2,3-cd)pyrene	1.11E-07	x	7.30E-01	=	8.08E-08	3.10E-07	/	NA	=	NA
Arsenic	1.91E-06	x	1.50E+00	=	**2.87E-06**	5.36E-06	/	3.00E-04	=	1.79E-02
Chromium	4.11E-06	x	5.00E-01	=	**2.05E-06**	1.15E-05	/	3.00E-03	=	3.83E-03
			Pathway total =		**6.84E-06**			Pathway total =		2.17E-02
Inhalation of Chemicals in Soil†										
Benz(a)anthracene	1.36E-05	x	1.10E-04	=	1.50E-09	3.81E-05	/	NA	=	NA
Benzo(a)pyrene	2.83E-06	x	1.10E-03	=	3.11E-09	7.92E-06	/	NA	=	NA
Benzo(b)fluoranthene	4.86E-06	x	1.10E-04	=	5.35E-10	1.36E-05	/	NA	=	NA
Benzo(k)fluoranthene	1.56E-06	x	1.10E-04	=	1.71E-10	4.36E-06	/	NA	=	NA
Carbazole	7.50E-10	x	NA	=	NA	2.10E-09	/	NA	=	NA
Chrysene	1.09E-05	x	1.10E-05	=	1.19E-10	3.04E-05	/	NA	=	NA
Dibenz(a,h)anthracene	4.04E-07	x	1.20E-03	=	4.85E-10	1.13E-06	/	NA	=	NA
Indeno(1,2,3-cd)pyrene	1.02E-06	x	1.10E-04	=	1.12E-10	2.85E-06	/	NA	=	NA
Arsenic	1.80E-07	x	4.30E-03	=	7.76E-10	5.05E-07	/	1.50E-02	=	3.37E-05
Chromium	3.87E-07	x	8.40E-02	=	3.25E-08	1.08E-06	/	1.00E-01	=	1.08E-05
			Pathway total =		3.93E-08			Pathway total =		4.45E-05
Dermal Contact with Chemicals in Soil										
Benz(a)anthracene	1.81E-07	x	7.30E-01	=	1.32E-07	5.07E-07	/	NA	=	NA
Benzo(a)pyrene	1.74E-07	x	7.30E+00	=	**1.27E-06**	4.87E-07	/	NA	=	NA
Benzo(b)fluoranthene	2.89E-07	x	7.30E-01	=	2.11E-07	8.11E-07	/	NA	=	NA
Benzo(k)fluoranthene	9.32E-08	x	7.30E-02	=	6.80E-09	2.61E-07	/	NA	=	NA
Carbazole	NA	x	NA	=	NA	NA	/	NA	=	NA
Chrysene	2.48E-07	x	7.30E-03	=	1.81E-09	6.95E-07	/	NA	=	NA
Dibenz(a,h)anthracene	4.97E-08	x	7.30E+00	=	3.62E-07	1.39E-07	/	NA	=	NA
Indeno(1,2,3-cd)pyrene	1.20E-07	x	7.30E-01	=	8.75E-08	3.36E-07	/	NA	=	NA
Arsenic	4.78E-07	x	1.50E+00	=	7.17E-07	1.34E-06	/	NA	=	NA
Chromium	NA	x	2.00E+01	=	NA	NA	/	NA	=	NA
			Pathway total =		**2.79E-06**			Pathway total =		0.00E+00
Chemical Totals										
Benz(a)anthracene			Sum of all pathways	=	2.56E-07			Sum of all pathways	=	NA
Benzo(a)pyrene			Sum of all pathways	=	**2.45E-06**			Sum of all pathways	=	NA
Benzo(b)fluoranthene			Sum of all pathways	=	4.07E-07			Sum of all pathways	=	NA
Benzo(k)fluoranthene			Sum of all pathways	=	1.33E-08			Sum of all pathways	=	NA
Carbazole			Sum of all pathways	=	NA			Sum of all pathways	=	NA
Chrysene			Sum of all pathways	=	3.61E-09			Sum of all pathways	=	NA
Dibenz(a,h)anthracene			Sum of all pathways	=	6.98E-07			Sum of all pathways	=	NA
Indeno(1,2,3-cd)pyrene			Sum of all pathways	=	1.68E-07			Sum of all pathways	=	NA
Arsenic			Sum of all pathways	=	**3.59E-06**			Sum of all pathways	=	1.79E-02
Chromium			Sum of all pathways	=	**2.09E-06**			Sum of all pathways	=	3.84E-03
	Total Carcinogenic Risk All Pathways and Chemicals			=	**9.66E-06**	Total Noncarcinogenic Risk All Pathways and Chemicals			=	2.17E-02

DI = Chemical Daily Intake
SF = Cancer Slope Factor
CR = Cancer Risk
RfD = Noncancer Reference Dose
HQ = Hazard Quotient

NA = not applicable; exposure parameters or toxicity parameters unavailable.
BOLD denotes cancer risks > 1E-06
†For the inhalation pathway, the Inhalation Unit Risk, with units of $(\mu g/m^3)^{-1}$, is used as the toxicity value, RfC.

Table B2.2
Risk Characterization
Construction Workers Exposed to Soil 0 - 9 ft of SMA 5
ERP Coke Facility, Birmingham, Alabama

	Carcinogenic Effects					Noncarcinogenic Effects				
Equation	**DI**	**x**	**SF**	**=**	**CR**	**DI**	**/**	**RfD**	**=**	**HQ**
Units	**mg/kg-day**		**(mg/kg-day)-1**		**unitless**	**mg/kg-day**		**mg/kg-day**		**unitless**
Ingestion of Chemicals in Soil										
Benz(a)anthracene	2.03E-07	x	7.30E-01	=	1.48E-07	1.42E-05	/	NA	=	NA
Benzo(a)pyrene	4.77E-07	x	7.30E+00	=	**3.48E-06**	3.34E-05	/	NA	=	NA
Benzo(b)fluoranthene	4.22E-07	x	7.30E-01	=	3.08E-07	2.96E-05	/	NA	=	NA
Benzo(k)fluoranthene	1.45E-07	x	7.30E-02	=	1.06E-08	1.02E-05	/	NA	=	NA
Carbazole	8.10E-08	x	NA	=	NA	5.67E-06	/	NA	=	NA
Chrysene	2.59E-07	x	7.30E-03	=	1.89E-09	1.81E-05	/	NA	=	NA
Dibenz(a,h)anthracene	1.17E-07	x	7.30E+00	=	8.56E-07	8.21E-06	/	NA	=	NA
Indeno(1,2,3-cd)pyrene	3.94E-07	x	7.30E-01	=	2.88E-07	2.76E-05	/	NA	=	NA
Naphthalene	2.41E-06	x	NA	=	NA	1.68E-04	/	2.00E-02	=	8.42E-03
Arsenic	5.57E-07	x	1.50E+00	=	8.35E-07	3.90E-05	/	3.00E-04	=	1.30E-01
Chromium	1.66E-06	x	5.00E-01	=	8.29E-07	1.16E-04	/	3.00E-03	=	3.87E-02
Mercury	1.02E-07	x	NA	=	na	7.12E-06	/	NA	=	NA
			Pathway total =		**6.76E-06**			Pathway total =		1.77E-01
Inhalation of Chemicals in Soil†										
Benz(a)anthracene	2.51E-06	x	1.10E-04	=	2.76E-10	1.76E-04	/	NA	=	NA
Benzo(a)pyrene	1.27E-06	x	1.10E-03	=	1.40E-09	8.91E-05	/	NA	=	NA
Benzo(b)fluoranthene	1.16E-06	x	1.10E-04	=	1.28E-10	8.14E-05	/	NA	=	NA
Benzo(k)fluoranthene	3.98E-07	x	1.10E-04	=	4.37E-11	2.78E-05	/	NA	=	NA
Carbazole	1.16E-09	x	NA	=	na	8.10E-08	/	NA	=	NA
Chrysene	1.85E-06	x	1.10E-05	=	2.04E-11	1.30E-04	/	NA	=	NA
Dibenz(a,h)anthracene	1.57E-07	x	1.20E-03	=	1.88E-10	1.10E-05	/	NA	=	NA
Indeno(1,2,3-cd)pyrene	5.49E-07	x	1.10E-04	=	6.04E-11	3.84E-05	/	NA	=	NA
Naphthalene	1.95E-03	x	3.40E-05	=	6.63E-08	1.36E-01	/	3.00E+00	=	4.55E-02
Arsenic	7.95E-09	x	4.30E-03	=	3.42E-11	5.57E-07	/	1.50E-02	=	3.71E-05
Chromium	2.37E-08	x	8.40E-02	=	1.99E-09	1.66E-06	/	1.00E-01	=	1.66E-05
Mercury	1.45E-09	x	NA	=	na	1.02E-07	/	3.00E-01	=	3.39E-07
			Pathway total =		7.04E-08			Pathway total =		4.55E-02
Dermal Contact with Chemicals in Soil										
Benz(a)anthracene	3.33E-08	x	7.30E-01	=	2.43E-08	2.33E-06	/	NA	=	NA
Benzo(a)pyrene	7.83E-08	x	7.30E+00	=	5.71E-07	5.48E-06	/	NA	=	NA
Benzo(b)fluoranthene	6.93E-08	x	7.30E-01	=	5.06E-08	4.85E-06	/	NA	=	NA
Benzo(k)fluoranthene	2.38E-08	x	7.30E-02	=	1.74E-09	1.67E-06	/	NA	=	NA
Carbazole	NA	x	NA	=	NA	NA	/	NA	=	NA
Chrysene	4.24E-08	x	7.30E-03	=	3.10E-10	2.97E-06	/	NA	=	NA
Dibenz(a,h)anthracene	1.92E-08	x	7.30E+00	=	1.40E-07	1.35E-06	/	NA	=	NA
Indeno(1,2,3-cd)pyrene	6.46E-08	x	7.30E-01	=	4.72E-08	4.53E-06	/	NA	=	NA
Naphthalene	3.95E-07	x	NA	=	NA	2.76E-05	/	2.00E-02	=	1.38E-03
Arsenic	2.11E-08	x	1.50E+00	=	3.16E-08	1.47E-06	/	3.00E-04	=	4.92E-03
Chromium	NA	x	2.00E+01	=	na	NA	/	7.50E-05	=	NA
Mercury	NA	x	NA	=	na	NA	/	NA	=	NA
			Pathway total =		8.67E-07			Pathway total =		6.30E-03
Chemical Totals										
Benz(a)anthracene			Sum of all pathways	=	1.73E-07			Sum of all pathways	=	NA
Benzo(a)pyrene			Sum of all pathways	=	**4.06E-06**			Sum of all pathways	=	NA
Benzo(b)fluoranthene			Sum of all pathways	=	3.59E-07			Sum of all pathways	=	NA
Benzo(k)fluoranthene			Sum of all pathways	=	1.24E-08			Sum of all pathways	=	NA
Carbazole			Sum of all pathways	=	NA			Sum of all pathways	=	NA
Chrysene			Sum of all pathways	=	2.22E-09			Sum of all pathways	=	NA
Dibenz(a,h)anthracene			Sum of all pathways	=	9.97E-07			Sum of all pathways	=	NA
Indeno(1,2,3-cd)pyrene			Sum of all pathways	=	3.35E-07			Sum of all pathways	=	NA
Naphthalene			Sum of all pathways	=	6.63E-08			Sum of all pathways	=	5.53E-02
Arsenic			Sum of all pathways	=	8.67E-07			Sum of all pathways	=	1.35E-01
Chromium			Sum of all pathways	=	8.31E-07			Sum of all pathways	=	3.87E-02
Mercury			Sum of all pathways	=	NA			Sum of all pathways	=	3.39E-07
	Total Carcinogenic Risk All Pathways and Chemicals			=	**7.70E-06**	Total Noncarcinogenic Risk All Pathways and Chemicals			=	2.29E-01

DI = Chemical Daily Intake
SF = Cancer Slope Factor
CR = Cancer Risk
RfD = Noncancer Reference Dose
HQ = Hazard Quotient

NA = not applicable; exposure parameters or toxicity parameters unavailable.
BOLD denotes cancer risks > 1E-06.
†For the inhalation pathway, the Inhalation Unit Risk, with units of $(\mu g/m^3)^{-1}$, is used as the toxicity value.

Table B3.1
Preliminary Cleanup Standards (PSCs)
Contribution from Ingestion of Chemicals in Soil
Industrial/Commercial Worker
ERP Coke Facility, Birmingham, Alabama

	Carcinogenic Effects																		
Equation	**Ing_C**	**= (**	**THQ**	**x**	**AT**	**x**	**BW**	**) / (**	**EF**	**x**	**ED**	**x**	**CSF**	**x**	**IR**	**x**	**CF**	**)**	
Units	**mg/Kg**		**unitless**		**years**		**Kg**		**days/yr**		**years**		**$(mg/Kg\text{-}day)^{-1}$**		**mg/day**		**Kg/mg**		
Benzo(a)pyrene	3.92E-01	= (	1.E-06	x	25550	x	70	) / (	250	x	25	x	7.30E+00	x	100	x	1.00E-06	)	
Arsenic	1.91E+00	= (	1.E-06	x	25550	x	70	) / (	250	x	25	x	1.50E+00	x	100	x	1.00E-06	)	
Chromium	5.72E+00	= (	1.E-06	x	25550	x	70	) / (	250	x	25	x	5.00E-01	x	100	x	1.00E-06	)	

	Noncarcinogenic Effects																					
Equation	**Ing_{NC}**	**= (**	**TR**	**x**	**AT**	**x**	**BW**	**) / (**	**EF**	**x**	**ED**	**x**	**(**	**1**	**/**	**RfD**	**) x**	**IR**	**x**	**CF**	**)**	
Units	**mg/Kg**		**unitless**		**years**		**Kg**		**days/yr**		**years**					**mg/Kg-day**		**mg/day**		**Kg/mg**		
Benzo(a)pyrene	na	= (	1.0	x	9125	x	70	) / (	250	x	25	x	(	1	/	na	) x	100	x	1.00E-06	)	
Arsenic	3.07E+02	= (	1.0	x	9125	x	70	) / (	250	x	25	x	(	1	/	3.00E-04	) x	100	x	1.00E-06	)	
Chromium	3.07E+03	= (	1.0	x	9125	x	70	) / (	250	x	25	x	(	1	/	3.00E-03	) x	100	x	1.00E-06	)	

IngC = Carcinogenic contribution from ingestion of chemicals in soil
THQ = Target Hazard Quotient
AT = Averaging time
BW = Body weight
EF = Exposure frequency
ED = Exposure duration
SF = Cancer Slope factor, oral
IR = Soil intake rate
CF = Conversion factor
RfD = Noncancer Reference dose, oral

nd = no data
na = not applicable

Table B3.2
Preliminary Cleanup Standards (PSCs)
Contribution from Dermal Contact with Chemicals in Soil
Industrial/Commercial Worker
ERP Coke Facility, Birmingham, Alabama

Carcinogenic Effects

Equation	$Derm_C$	= (	TR	x	AT	x	BW	) / (	EF	x	ED	x	CSF	x	SAF	x	SSA	x	EV	x	ABSd	x	CF	)
Units	mg/kg		unitless		days		Kg		days/year		years		$(mg/Kg\text{-}day)^{-1}$		mg/cm^2-event		cm^2		events/day		unitless		Kg/mg	
Benzo(a)pyrene	4.57E-01	= (	1.00E-06	x	25550	x	70	) / (	250	x	25	x	7.30E+00	x	0.2	x	3300	x	1	x	0.13	x	1.00E-06	)
Arsenic	9.64E+00	= (	1.00E-06	x	25550	x	70	) / (	250	x	25	x	1.50E+00	x	0.2	x	3300	x	1	x	0.03	x	1.00E-06	)
Chromium	na	= (	1.00E-06	x	25550	x	70	) / (	250	x	25	x	2.00E+01	x	0.2	x	3300	x	1	x	nd	x	1.00E-06	)

Noncarcinogenic Effects

Equation	$Derm_{NC}$	= (	THQ	x	AT	x	BW	) / (	EF	x	ED	x (1 /	RfD	x	SAF	x	SSA	x	EV	x	ABSd	x	CF	)
Units	mg/kg		unitless		days		Kg		days/year		years		$(mg/Kg\text{-}day)^{-1}$		mg/cm^2-event		cm^2		events/day		unitless		Kg/mg	
Benzo(a)pyrene	na	= (	1	x	9125	x	70	) / (	250	x	25	x (1 /	na	x	0.2	x	3300	x	1	x	0.13	x	1.00E-06	)
Arsenic	1.55E+03	= (	1	x	9125	x	70	) / (	250	x	25	x (1 /	3.00E-04	x	0.2	x	3300	x	1	x	0.03	x	1.00E-06	)
Chromium	na	= (	1	x	9125	x	70	) / (	250	x	25	x (1 /	7.50E-05	x	0.2	x	3300	x	1	x	nd	x	1.00E-06	)

$Derm_C$ = Carcinogenic contribution from inhalation of chemicals in soil
TR = Target Risk
AT = Averaging time
BW = Body weight
EF = Exposure frequency
ED = Exposure duration
CSF = Cancer Slope Factor, dermal
SAF = Skin/Soil Adherence Factor
SSA = Skin Surface Area
EV = Event frequency
ABS = Dermal Absorption Factor
$Derm_{NC}$ = Noncarcinogenic contribution from inhalation of chemicals in soil
THQ = Target Hazard Quotient
RfD = Noncancer Reference Dose, inhalation

Table B3.3
Preliminary Cleanup Standards (PSCs)
Contribution from Inhalation of Chemicals in Soil
Industrial/Commercial Worker
ERP Coke Facility, Birmingham, Alabama

													Carcinogenic Effects									
Equation	**Inh_C**	**= (**	**TR**	**x**	**AT**	**) / (**	**EF**	**x**	**ED**	**x**	**ET**	**x**	**CF_1**	**x**	**IUR**	**x**	**CF_2**	**x [(1 /**	**VF**	**) + (1 /**	**PEF**	**)]**
Units	**mg/Kg**		**unitless**		**days**		**days/year**		**years**		**hours/day**		**days/hour**		**$(\mu g/m^3)^{-1}$**		**µg/mg**		**m^3/Kg**		**m^3/Kg**	
Benzo(a)pyrene	5.61E+01	= (	1.00E-06	x	25550	) / (	250	x	25	x	8	x	0.042	x	1.10E-03	x	1000	x [(1 /	5.08E+06	) + (1 /	5.70E+09	)]
Arsenic	1.61E+04	= (	1.00E-06	x	25550	) / (	250	x	25	x	8	x	0.042	x	4.30E-03	x	1000	x [(1 /	na	) + (1 /	5.70E+09	)]
Chromium	8.26E+02	= (	1.00E-06	x	25550	) / (	250	x	25	x	8	x	0.042	x	8.40E-02	x	1000	x [(1 /	na	) + (1 /	5.70E+09	)]

Table B3.3 (cont.)
Preliminary Cleanup Standards (PSCs)
Contribution from Inhalation of Chemicals in Soil
Industrial/Commercial Worker
ERP Coke Facility, Birmingham, Alabama

Noncarcinogenic Effects

Equation	Inh_{NC}	= (	THQ	x	AT	) / (	EF	x	ED	x	ET	x	CF	x (1 /	RfC	) x [(1 /	VF	) + (1 /	PEF	)]
Units	mg/Kg		unitless		days		days/year		years		hours/day		days/hour		mg/m^3		m^3/Kg		m^3/Kg	
Benzo(a)pyrene	na	= (	1.0	x	9125	) / (	250	x	25	x	8	x	0.042	x (1 /	na	) x [(1 /	5.08E+06	) + (1 /	5.70E+09	)]
Arsenic	3.72E+05	= (	1.0	x	9125	) / (	250	x	25	x	8	x	0.042	x (1 /	#######	) x [(1 /	na	) + (1 /	5.70E+09	)]
Chromium	2.48E+06	= (	1.0	x	9125	) / (	250	x	25	x	8	x	0.042	x (1 /	#######	) x [(1 /	na	) + (1 /	5.70E+09	)]

Inh_C = Carcinogenic contribution from the inhalation of chemicals in soil
TR = Target Risk
AT = Averaging time
EF = Exposure frequency
ED = Exposure duration
ET = Exposure time
CF_1 = Conversion factor, day/hours
IUR = Inhalation Unit Risk
CF_2 = Conversion factor, g/mg
CSF = Cancer Slope Factor, inhalation
VF = Volatilization factor
PEF = Particulate emission factor
Inh_{NC} = Noncarcinogenic contribution from the dermal absorption of chemicals in soil
THQ = Target Hazard Quotient
RfC = Noncancer Reference concentration, inhalation

Table B3.4
Preliminary Cleanup Standards (PSCs)
Contribution from Ingestion of Chemicals in Soil
Construction Worker
ERP Coke Facility, Birmingham, Alabama

	Carcinogenic Effects																				
Equation	**Ing_C**	**= (**	**THQ**	**x**	**AT**	**x**	**BW**	**) / (**	**EF**	**x**	**ED**		**x**		**SF**		**x**	**IR**	**x**	**CF**	**)**
Units	**mg/Kg**		**unitless**		**years**		**Kg**		**days/yr**		**years**				**$(mg/Kg\text{-}day)^{-1}$**			**mg/day**		**Kg/mg**	
Benzo(a)pyrene	2.97E+00	= (	1.E-06	x	25550	x	70	) / (	250	x	1		x		7.30E+00		x	330	x	1.00E-06	)
Dibenzo(a,h)anthracene	2.97E+00	= (	1.E-06	x	25550	x	70	) / (	250	x	1		x		7.30E+00		x	330	x	1.00E-06	)

	Noncarcinogenic Effects																				
Equation	**Ing_{NC}**	**= (**	**TR**	**x**	**AT**	**x**	**BW**	**) / (**	**EF**	**x**	**ED**	**x**	**(**	**1 /**	**RfD**	**)**	**x**	**IR**	**x**	**CF**	**)**
Units	**mg/Kg**		**unitless**		**years**		**Kg**		**days/yr**		**years**				**mg/Kg-day**			**mg/day**		**Kg/mg**	
Benzo(a)pyrene	na	= (	1.0	x	365	x	70	) / (	250	x	1	x	(	1 /	na	)	x	330	x	1.00E-06	)
Dibenzo(a,h)anthracene	na	= (	1.0	x	365	x	70	) / (	250	x	1	x	(	1 /	na	)	x	330	x	1.00E-06	)

IngC = Carcinogenic contribution from ingestion of chemicals in soil
THQ = Target Hazard Quotient
AT = Averaging time
BW = Body weight
EF = Exposure frequency
ED = Exposure duration
SF = Cancer Slope factor, oral
IR = Soil intake rate
CF = Conversion factor
RfD = Noncancer Reference dose, oral
nd = no data
na = not applicable

Table B3.5
Preliminary Cleanup Standards (PSCs)
Contribution from Dermal Contact with Chemicals in Soil
Construction Worker
ERP Coke Facility, Birmingham, Alabama

													Carcinogenic Effects												
Equation	**$Derm_C$**	**= (**	**TR**	**x**	**AT**	**x**	**BW**	**) / (**	**EF**	**x**	**ED**	**x**	**CSF**	**x**	**SAF**	**x**	**SSA**	**x**	**EV**	**x**	**ABS_d**	**x**	**CF**	**)**
Units	**mg/kg**		**unitless**		**days**		**Kg**		**days/year**		**years**		**$(mg/Kg\text{-}day)^{-1}$**		**mg/cm^2-event**		**cm^2**		**events/day**		**unitless**		**Kg/mg**	
Benzo(a)pyrene	1.14E+01	= (	1.00E-06	x	25550	x	70	) / (	250	x	1	x	7.30E+00	x	0.2	x	3300	x	1	x	0.13	x	1.00E-06	)
Dibenzo(a,h)anthracene	1.14E+01	= (	1.00E-06	x	25550	x	70	) / (	250	x	1	x	7.30E+00	x	0.2	x	3300	x	1	x	0.13	x	1.00E-06	)

													Noncarcinogenic Effects											
Equation	**$Derm_{NC}$**	**= (**	**THQ**	**x**	**AT**	**x**	**BW**	**) / (**	**EF**	**x**	**ED**	**x (1 /**	**RfD**	**) x**	**SAF**	**x**	**SSA**	**x**	**EV**	**x**	**ABS_d**	**x**	**CF**	**)**
Units	**mg/kg**		**unitless**		**days**		**Kg**		**days/year**		**years**		**$(mg/Kg\text{-}day)^{-1}$**		**mg/cm^2-event**		**cm^2**		**events/day**		**unitless**		**Kg/mg**	
Benzo(a)pyrene	na	= (	1	x	365	x	70	) / (	250	x	1	x (1 /	na	) x	0.2	x	3300	x	1	x	0.13	x	1.00E-06	)
Dibenzo(a,h)anthracene	na	= (	1	x	365	x	70	) / (	250	x	1	x (1 /	na	) x	0.2	x	3300	x	1	x	0.13	x	1.00E-06	)

$Derm_C$ = Carcinogenic contribution from inhalation of chemicals in soil
TR = Target Risk
AT = Averaging time
BW = Body weight
EF = Exposure frequency
ED = Exposure duration
CSF = Cancer Slope Factor, dermal
SAF = Skin/Soil Adherence Factor
SSA = Skin Surface Area
EV = Event frequency
ABS = Dermal Absorption Factor
$Derm_{NC}$ = Noncarcinogenic contribution from inhalation of chemicals in soil
THQ = Target Hazard Quotient
RfD = Noncancer Reference Dose, inhalation

Table B3.6
Preliminary Cleanup Standards (PSCs)
Contribution from Inhalation of Chemicals in Soil
Construction Worker
ERP Coke Facility, Birmingham, Alabama

											Carcinogenic Effects											
Equation	**Inh_C**	**= (**	**TR**	**x**	**AT**	**) / (**	**EF**	**x**	**ED**	**x**	**ET**	**x**	**CF**	**x**	**IUR**	**x**	**CF**	**x [(1 /**	**VF**	**) + (1 /**	**PEF**	**)]**
Units	**mg/Kg**		**unitless**		**days**		**days/year**		**years**		**hours/day**		**days/hour**		**$(\mu g/m^3)^{-1}$**		**µg/mg**		**m^3/Kg**		**m^3/Kg**	
Benzo(a)pyrene	1.40E+03	= (	1.00E-06	x	25550	) / (	250	x	1	x	8	x	0.042	x	1.10E-03	x	1000	x [(1 /	5.08E+06	) + (1 /	5.70E+09	)]
Dibenzo(a,h)anthracene	5.96E+03	= (	1.00E-06	x	25550	) / (	250	x	1	x	8	x	0.042	x	1.20E-03	x	1000	x [(1 /	2.36E+07	) + (1 /	5.70E+09	)]

Table B3.6 (cont.)
Preliminary Cleanup Standards (PSCs)
Contribution from Inhalation of Chemicals in Soil
Construction Worker
ERP Coke Facility, Birmingham, Alabama

																	Noncarcinogenic Effects																	
Equation	**INH_{NC}**	**= (**	**THQ**	**x**	**AT**	**) / (**	**EF**	**x**	**ED**	**x**	**ET**	**x**	**CF**	**x (**	**1**	**/**	**RfC**	**) x [**	**(**	**1**	**/**	**VF**	**)**	**+**	**(**	**1**	**/**	**PEF**	**)]**					
Units	**mg/Kg**		**unitless**		**days**		**days/year**		**years**		**hours/day**		**days/hour**				**mg/m^3**					**m^3/Kg**						**m^3/Kg**						
Benzo(a)pyrene	na	= (	1.0	**x**	365	) / (	250	x	1	x	8	x	0.042	x (	1	/	na	) x [	(	1	/	5.08E+06	)	+	(	1	/	5.70E+09	)]					
Dibenzo(a,h)anthracene	na	= (	1.0	**x**	365	) / (	250	x	1	x	8	x	0.042	x (	1	/	na	) x [	(	1	/	2.36E+07	)	+	(	1	/	5.70E+09	)]					

Inh_C = Carcinogenic contribution from the inhalation of chemicals in soil
TR = Target Risk
AT = Averaging time
EF = Exposure frequency
ED = Exposure duration
ET = Exposure time
CF_1 = Conversion factor, day/hours
IUR = Inhalation Unit Risk
CF_2 = Conversion factor, g/mg
CSF = Cancer Slope Factor, inhalation
VF = Volatilization factor
PEF = Particulate emission factor
Inh_{NC} = Noncarcinogenic contribution from the dermal absorption of chemicals in soil
THQ = Target Hazard Quotient
RfC = Noncancer Reference concentration, inhalation

Table B3.7
Noncarcinogenic Preliminary Cleanup Standards (PSCs) for SMA 1 Soil
ERP Coke Facility, Birmingham, Alabama

Equation	RGO	= 1 / [(1 /	Ing_{NC}	) + (1 /	$Derm_{NC}$	) + (1 /	Inh_{NC}	)]
Units	mg/kg							
Industrial Worker								
Benzo(a)pyrene	na	= 1 / [(1 /	na	) + (1 /	na	) + (1 /	na	)]
Arsenic	2.56E+02	= 1 / [(1 /	3.07E+02	) + (1 /	1.55E+03	) + (1 /	3.72E+05	)]
Chromium	3.06E+03	= 1 / [(1 /	3.07E+03	) + (1 /	na	) + (1 /	2.48E+06	)]
Construction Worker								
Benzo(a)pyrene	na	= 1 / [(1 /	na	) + (1 /	na	) + (1 /	na	)]
Dibenzo(a,h)anthracene	na	= 1 / [(1 /	na	) + (1 /	na	) + (1 /	na	)]

RGO = Remedial Goal Objective
IngNC = Noncancer contribution from ingestion of chemicals in soil
DermNC = Noncancer contribution from dermal contact with chemicals in soil
InhNC = Noncancer contribution from inhalation of chemicals in soil

Table B3.8
Carcinogenic Preliminary Cleanup Standards (PSCs) for SMA 1 Soil
ERP Coke Facility, Birmingham, Alabama

Equation	**RGO**	**= 1 / (1 /**	**Ing_C**	**) + (1 /**	**$Derm_C$**	**) + (1 /**	**Inh_C**	**)**
Units	**mg/kg**							
<u>Industrial Worker</u>								
Benzo(a)pyrene	2.10E-01	= 1 / (1 /	3.92E-01	) + (1 /	4.57E-01	) + (1 /	5.61E+01	)
Arsenic	1.59E+00	= 1 / (1 /	1.91E+00	) + (1 /	9.64E+00	) + (1 /	1.61E+04	)
Chromium	5.68E+00	= 1 / (1 /	5.72E+00	) + (1 /	na	) + (1 /	8.26E+02	)
<u>Construction Worker</u>								
Benzo(a)pyrene	2.35E+00	= 1 / (1 /	2.97E+00	) + (1 /	1.14E+01	) + (1 /	1.40E+03	)
Dibenzo(a,h)anthracene	2.36E+00	= 1 / (1 /	2.97E+00	) + (1 /	1.14E+01	) + (1 /	5.96E+03	)

RGO = Remedial Goal Objective
Ing_C = Noncancer contribution from ingestion of chemicals in soil
$Derm_C$ = Noncancer contribution from dermal contact with chemicals in soil
Inh_C = Noncancer contribution from inhalation of chemicals in soil

APPENDIX C

BORING LOGS

BORING LOG NO. SB43001

PROJECT: Corrective Measures Study | **CLIENT: ERP COKE**

SITE: **SMA 5 - Former Pig Iron Foundry, Birmingham, Alabama**

LOCATION 33°35'56.4894" N, 086°47'57.9294" W

GRAPHIC LOG	DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	SPT N-VALUE	OVA/PID (ppm)
		SANDY SILT, black, very fine grained					
					X	5-5-5-5 N=10	<1
		some foundry slag at 3 feet			X	5-5-5-6 N=10	NR
			5		X	5-5-4-5 N=9	<1
		color change to white with intermittent black layers at 7 feet			X	1-2-3-4 N=5	<1
	9.0	**CLAY**, olive, tan, and orange mottled					
			10		X	1-1-1-1 N=2	<1
		groundwater encountered at 11 feet		▽			
	13.0	***Boring Terminated at 13 Feet***					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Hollow stem auger

Abandonment Method:

See Appendices for description of field procedures.

See Appendices for description of laboratory procedures and additional data (if any).

See Appendices for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water observed at 11 feet*

Terracon
110 12th Street North
Birmingham, Alabama

Boring Started: 6/17/2014	Boring Completed: 6/17/2014
Drill Rig: CME-65	Driller: Terracon
Project No.: E1147106	Exhibit: B-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ENVIRONMENTAL SMART LOG E1147106 CORRECTIVE MEASURES STUDY.GPJ ENV STANDARD 2012.GDT 9/8/14

BORING LOG NO. SB43002

PROJECT: Corrective Measures Study

CLIENT: ERP COKE

SITE: SMA 5 - Former Pig Iron Foundry Birmingham, Alabama

LOCATION 33°34'8.7" N, 086°47'58.07" W

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	SPT N-VALUE	OVA/PID (ppm)
	SAND, white with clayey sand, black and foundry slag intermixed					
				X	5-7-5-3 N=12	<1
				X	3-3-3-3 N=6	<1
		5		X	1-2-2-1 N=4	<1
9.0	groundwater encountered at 9 feet		▽	X	NS	NR
11.0	**SANDY CLAY**, olive-black, wet	10				
	Boring Terminated at 11 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Hollow stem auger

Abandonment Method:

See Appendices for description of field procedures.

See Appendices for description of laboratory procedures and additional data (if any).

See Appendices for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water observed at 9 feet*

Terracon
110 12th Street North
Birmingham, Alabama

Boring Started: 6/17/2014	Boring Completed: 6/17/2014
Drill Rig: CME-65	Driller: Terracon
Project No.: E1147106	Exhibit: B-2

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ENVIRONMENTAL SMART LOG E1147106 CORRECTIVE MEASURES STUDY.GPJ ENV STANDARD 2012.GDT 9/8/14

BORING LOG NO. SB43003

PROJECT: Corrective Measures Study

CLIENT: ERP COKE

SITE: SMA 5 - Former Pig Iron Foundry
Birmingham, Alabama

LOCATION 33°33'38.988" N, 086°47'57.354" W

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	SPT N-VALUE	OVA/PID (ppm)
	FOUNDRY SAND/SILT, black					
				X	3-3-5-5 N=8	<1
4.0				X	2-2-4-1 N=6	<1
	SANDY CLAY, orange, red, and tan mottled	5				
7.0	groundwater encountered at 7 feet		▽	X	4-3-3-1 N=6	NR
	Boring Terminated at 7 Feet			X	0-1-1-1 N=2	

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Hollow stem auger

Abandonment Method:

See Appendices for description of field procedures.

See Appendices for description of laboratory procedures and additional data (if any).

See Appendices for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water observed at 7 feet*

Terracon
110 12th Street North
Birmingham, Alabama

Boring Started: 6/17/2014	Boring Completed: 6/17/2014
Drill Rig: CME-65	Driller: Terracon
Project No.: E1147106	Exhibit: B-3

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ENVIRONMENTAL SMART LOG E1147106 CORRECTIVE MEASURES STUDY.GPJ ENV STANDARD 2012.GDT 9/8/14

BORING LOG NO. SB44001

PROJECT: Corrective Measures Study

CLIENT: ERP COKE

SITE: SMA 5 - Former Pig Iron Foundry
Birmingham, Alabama

LOCATION 33°34'06.7" N, 086°47'54.2" W

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	SPT N-VALUE	OVA/PID (ppm)
0.8	**FOUNDRY SILT**, black				7-15	2.2
2.5	**SANDY CLAY**, gray, red, and tan mottled with bricks and limestone pebbles, dry				8-12-6-14 N=18	3.6
5.0	**SILTY CLAY**, gray-orange to gray and tan-orange mottled, soft	5			3-4-6-9 N=10	2.2
	Auger Refusal at 5 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Hollow stem auger

Abandonment Method:

See Appendices for description of field procedures.

See Appendices for description of laboratory procedures and additional data (if any).

See Appendices for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

None

Terracon
110 12th Street North
Birmingham, Alabama

Boring Started: 6/16/2014	Boring Completed: 6/16/2014
Drill Rig: CME-65	Driller: Terracon
Project No.: E1147106	Exhibit: B-4

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ENVIRONMENTAL SMART LOG E1147106 CORRECTIVE MEASURES STUDY.GPJ ENV STANDARD 2012.GDT 9/8/14

BORING LOG NO. SB44002

PROJECT: Corrective Measures Study

CLIENT: ERP COKE

SITE: SMA 5 - Former Pig Iron Foundry, Birmingham, Alabama

LOCATION 33°34'06.3" N, 086°47'54.1" W

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	SPT N-VALUE	OVA/PID (ppm)
	SILT, black, some slag and sand				18-22	<1
2.8					6-16-9-7 N=25	<1
	CLAY, tan, red, and brown mottled, soft, moist, with limestone granules				3-3-3-8 N=6	<1
5.0		5				
	Auger Refusal at 5 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Hollow stem auger

Abandonment Method:

See Appendices for description of field procedures.

See Appendices for description of laboratory procedures and additional data (if any).

See Appendices for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

None

Terracon
110 12th Street North
Birmingham, Alabama

Boring Started: 6/16/2014	Boring Completed: 6/16/2014
Drill Rig: CME-65	Driller: Terracon
Project No.: E1147106	Exhibit: B-5

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ENVIRONMENTAL SMART LOG E1147106 CORRECTIVE MEASURES STUDY.GPJ ENV STANDARD 2012.GDT 9/8/14

BORING LOG NO. SB44003

PROJECT: Corrective Measures Study

CLIENT: ERP COKE

SITE: SMA 5 - Former Pig Iron Foundry Birmingham, Alabama

LOCATION 33°34'0.64" N, 086°47'54.5" W

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	SPT N-VALUE	OVA/PID (ppm)
	SILTY SAND, black, friable				12-13	<1
3.0					7-16-12-12 N=28	<1
	CLAY, black to dark olive, moist, soft					
5.0		5			5-3-5-8 N=8	<1
	Auger Refusal at 5 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Hollow stem auger

Abandonment Method:

See Appendices for description of field procedures.

See Appendices for description of laboratory procedures and additional data (if any).

See Appendices for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

None

Terracon
110 12th Street North
Birmingham, Alabama

Boring Started: 6/16/2014	Boring Completed: 6/16/2014
Drill Rig: CME-65	Driller: Terracon
Project No.: E1147106	Exhibit: B-6

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ENVIRONMENTAL SMART LOG E1147106 CORRECTIVE MEASURES STUDY.GPJ ENV STANDARD 2012.GDT 9/8/14

BORING LOG NO. SB45001

PROJECT: Corrective Measures Study

CLIENT: ERP COKE

SITE: SMA 5 - Former Pig Iron Foundry, Birmingham, Alabama

LOCATION 33°34'06.0" N, 086°47'53.2" W

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	SPT N-VALUE	OVA/PID (ppm)
0.2	**TOPSOIL**					
	CLAY, black, soft			X	7-7	<1
3.0				X	3-50/4"	<1
	CLAYEY SAND, brown to black, fine-grained					
5.0		5		X	17-19-20-15 N=39	<1
	Auger Refusal at 5 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Hollow stem auger

Abandonment Method:

See Appendices for description of field procedures.

See Appendices for description of laboratory procedures and additional data (if any).

See Appendices for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

None

Terracon
110 12th Street North
Birmingham, Alabama

Boring Started: 6/16/2014	Boring Completed: 6/16/2014
Drill Rig: CME-65	Driller: Terracon
Project No.: E1147106	Exhibit: B-7

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ENVIRONMENTAL SMART LOG E1147106 CORRECTIVE MEASURES STUDY.GPJ ENV STANDARD 2012.GDT 9/8/14

BORING LOG NO. SB45002

PROJECT: Corrective Measures Study

CLIENT: ERP COKE

SITE: SMA 5 - Former Pig Iron Foundry, Birmingham, Alabama

LOCATION 33°34'06.2" N, 086°47'50.3" W

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	SPT N-VALUE	OVA/PID (ppm)
1.0	**GRAVEL**					
	SAND, black, with some silt and clay			X	7-7-5-5 N=12	<1
5.0		5		X	4-5-5-6 N=10	<1
	Groundwater Encountered and Auger Refusal at 5 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Hollow stem auger

Abandonment Method:

See Appendices for description of field procedures.

See Appendices for description of laboratory procedures and additional data (if any).

See Appendices for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

None

Terracon
110 12th Street North
Birmingham, Alabama

Boring Started: 6/16/2014	Boring Completed: 6/16/2014
Drill Rig: CME-65	Driller: Terracon
Project No.: E1147106	Exhibit: B-8

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ENVIRONMENTAL SMART LOG E1147106 CORRECTIVE MEASURES STUDY.GPJ ENV STANDARD 2012.GDT 9/8/14

BORING LOG NO. SB45003

PROJECT: Corrective Measures Study

CLIENT: ERP COKE

SITE: SMA 5 - Former Pig Iron Foundry Birmingham, Alabama

GRAPHIC LOG	LOCATION 33°34'03.7" N, 086°47'50.8" W DEPTH / MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	SPT N-VALUE	OVA/PID (ppm)
	SILT, black, with concrete-like gravel			X	5-50/2"	<1
	2.5			X	50/5.5"	<1
	Auger Refusal at 2.5 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Hollow stem auger

Abandonment Method:

See Appendices for description of field procedures.

See Appendices for description of laboratory procedures and additional data (if any).

See Appendices for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

None

Terracon
110 12th Street North
Birmingham, Alabama

Boring Started: 6/16/2014	Boring Completed: 6/16/2014
Drill Rig: CME-65	Driller: Terracon
Project No.: E1147106	Exhibit: B-9

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ENVIRONMENTAL SMART LOG E1147106 CORRECTIVE MEASURES STUDY.GPJ ENV STANDARD 2012.GDT 9/8/14

BORING LOG NO. SB45004

PROJECT: Corrective Measures Study

CLIENT: ERP COKE

SITE: SMA 5 - Former Pig Iron Foundry
Birmingham, Alabama

LOCATION 33°34'03.9" N, 086°47'52.6" W

GRAPHIC LOG	DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	SPT N-VALUE	OVA/PID (ppm)
	1.0	**GRAVEL**					
	2.5	**SILT**, black, with concrete-like gravel				50/5.5"	<1
		Auger Refusal at 2.5 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Hollow stem auger

Abandonment Method:

See Appendices for description of field procedures.

See Appendices for description of laboratory procedures and additional data (if any).

See Appendices for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

None

Terracon
110 12th Street North
Birmingham, Alabama

Boring Started: 6/16/2014	Boring Completed: 6/16/2014
Drill Rig: CME-65	Driller: Terracon
Project No.: E1147106	Exhibit: B-10

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ENVIRONMENTAL SMART LOG E1147106 CORRECTIVE MEASURES STUDY.GPJ ENV STANDARD 2012.GDT 9/8/14